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KAISER•HILL
COMPANY

PROGRESS REPORT #1 TO THE SOURCE EVALUATION AND PRELIMINARY MITIGATION PLAN FOR WALNUT CREEK

RMRS Rocky Mountain
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REVISION 0

• Environmental Restoration •
Rocky Flats Environmental Technology Site

September, 1997

ADMIN RECORD

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PROGRESS REPORT #1 TO THE SOURCE EVALUATION AND PRELIMINARY MITIGATION PLAN FOR WALNUT CREEK

REVISION 0

September, 1997

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TABLES

1. INTRODUCTION

This Source Evaluation Progress Report is provided in accordance with the Final Rocky Flats Cleanup Agreement (RFCA) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting of "exceedances in Segment 5" and when "standards are exceeded at a POC" and that a "source evaluation and mitigating action will be required". Specifically, this source evaluation addresses the August 15, 1997 Rocky Flats Environmental Technology Site (Site) report of elevated 30-day moving averages for plutonium (Pu) and americium (Am) water-quality results in Walnut Creek. These elevated values were measured at the Point of Compliance (POC) monitoring location at Walnut Creek and Indiana Street (referred to as GS03) for the period June 12, 1997 through July 2,1997. Elevated values were also measured at the Point of Evaluation (POE) monitoring location above Pond B-1 (referred to as GS10) for the period April 13, 1997 through April 24,1997, and May 25, 1997 through June 20, 1997. Finally, elevated values were observed at the POE monitoring location above Pond A-1 (referred to as SW093) for the period August 2, 1997 through August 3,1997. This Source Evaluation Progress Report #1 is the first in a series the Site has committed to completing as outlined in Source Evaluation and Preliminary Proposed Mitigating Actions for Walnut Creek Water-Quality Results, September 1997 (Revision 2; RF/RMRS-97-081.UN). This Plan was delivered to CDPHE, EPA, City of Broomfield and City of Westminster, on September 15, 1997.

The Site considers the recent elevated water quality measurements at GS03 serious in nature. Elevated values such as these have not previously been measured at this location. The Site maintains open communication with regulators, cities, and stakeholders to relay the progress of the investigation. The Site has initiated a surface-water source investigation incorporating a multitude of onsite and offsite expertise, as well as state-of-the-art research methods and technologies. The Site has initiated extensive data evaluations, additional field investigations (soil, sediment, and water analyses), and assessments of Site activities and monitoring programs. Activities and administrative changes have been implemented as quickly as practicable to locate a source and continue to protect water quality. The Walnut Creek source location activities undertaken by the Site thus far, indicate that the GS03 exceedance is most likely the result of legacy contamination. The source evaluation has uncovered no information that indicates that recent Site activities are responsible.

In order to allow sufficient time for effective source evaluation, while simultaneously providing the more frequent dissemination of information and results as they become available, a series of three Source Evaluation Progress Reports, and a Final Source Evaluation and Mitigating Action Plan will be completed. Progress Reports will be produced at intervals during the source evaluation process as specific actions are completed. During the production of each deliverable, additional information will be collected which will be included in subsequent reports as available. Data collection schedules are often weather dependent (collection of runoff samples) and subject to laboratory analysis turnaround times. The scope of additional information collection is flexible and should be expected to change based on the knowledge gained during the source evaluation activities. The schedule is given in Table 1-1.

Table 1-1. Schedule of Deliverables

Deliverable	Completion Date
Source Evaluation Progress Report #1	September 30, 1997
Source Evaluation Progress Report #2	November 17, 1997
Source Evaluation Progress Report #3	December 31, 1997
Final Source Evaluation Report and Mitigating Action Plan	April 15, 1998

Source evaluations require analysis of constituent fate, transport, and loading, as well as statistical analysis and the establishment of water-quality correlations which may indicate the location of a contaminant source. This Report #1 describes the progress of source evaluation actions for Walnut Creek gaging stations GS03 and GS10 and covers data received by September 15, 1997. Preliminary source evaluation for SW093 will be included in Report #2, since the data was received on September 16, 1997. Source evaluations are required to determine the location, extent, and significance of areas which may have an impact on surface water quality. This Source Evaluation Progress Report #1 includes the assessment of current existing monitoring data primarily for GS03 and information requested by CDPHE in a letter dated August 5, 1997. The following is included in this Report #1 for Walnut Creek:

- An evaluation of sampling and analysis QA/QC protocol to verify elevated water-quality results;
- Conclusions and hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations;
- A statistical assessment of existing monitoring data;
- A summary of current Actinide Migration Study findings with cross-links to source evaluations;
- Details on the new monitoring locations upgradient of GS03 and GS10;
- An initial qualitative evaluation for GS10;
- A discussion of the recent change from rising-limb to continuous flow-paced sampling at RFCA POE and POC locations; and
- A summary of the status for sampling and operational modifications.

2. BACKGROUND

2.1. SITE HYDROLOGY

Walnut Creek, the subject of this investigation and one of several Site drainages, flows east past the Site's boundary at Indiana Street. Surface water monitoring station GS03, where the samples of concern were collected, is located on Walnut Creek approximately 100 yards west of Indiana Street. Downstream of Indiana Street, Walnut Creek continues its easterly course and flows around Great Western Reservoir on the south via the Broomfield Diversion Ditch, into Big Dry Creek, and on to the South Platte River.

Walnut Creek Tributaries

Upstream from station GS03, Walnut Creek receives flow from the following four tributaries (listed in order from north to south and shown in Figure 2-1):

- McKay ByPass Canal (Coal Creek water conveyance canal);
- No Name Gulch (buffer zone drainage basin east of the Landfill Pond);
- North Walnut Creek (northern Industrial Area (IA) drainage basin); and
- South Walnut Creek (central IA drainage basin).

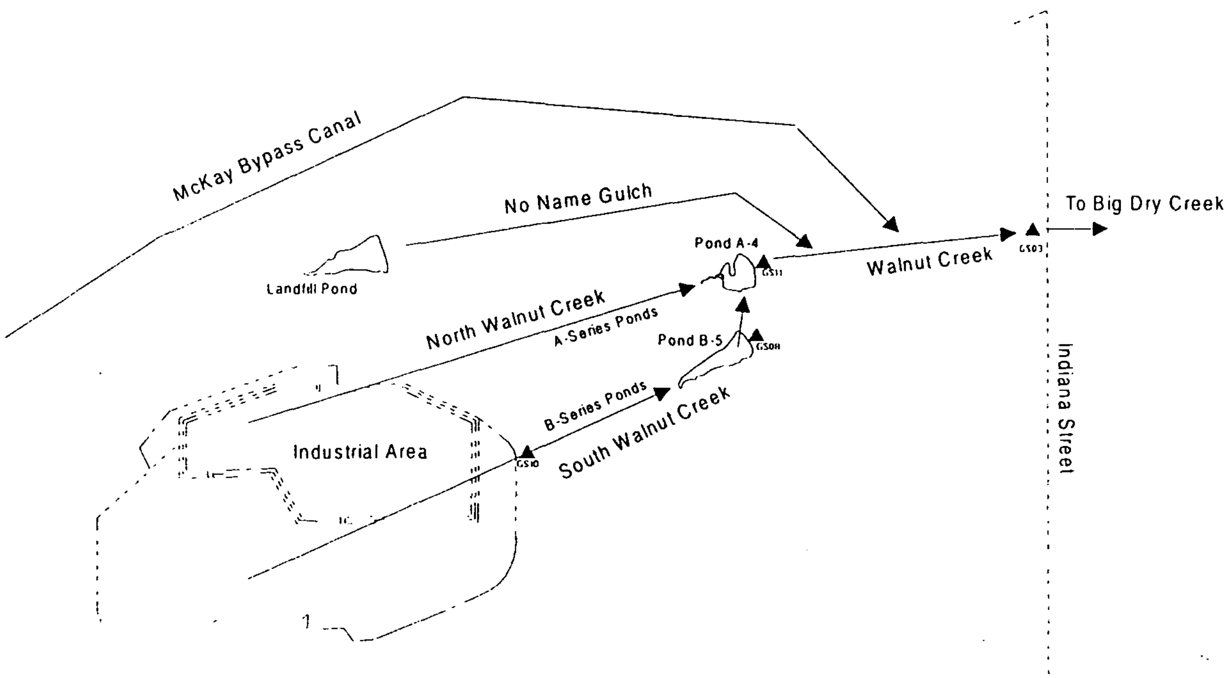

Figure 2-1. Hydrologic Connectivity of Site Drainage and Water Management Features.

No Name Gulch and the McKay Bypass Canal flow only during the spring or following large storm events, receive runoff from non-IA drainage basins, and are not controlled by detention ponds. North and South Walnut Creek, in contrast, both have nearly continuous baseflow, receive runoff from the IA, and are controlled by a system of detention ponds. A discussion follows describing how water runs off the IA, into North and South Walnut Creeks, through the detention pond network, and, ultimately, into Walnut Creek where it flows past station GS03.

North and South Walnut Creek Flow Controls

All IA surface-water runoff that flows into North or South Walnut Creek is collected in a system of Site detention ponds. The ponds serve three main purposes for surface water management: (1) storm water detention and settling of sediments, (2) holding water for sampling and, as necessary, treatment prior release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

South Walnut Creek water is routed through the B-Series ponds[1]. Steps in the water collection and transfer process are briefly outlined as follows:

- Runoff from the central portion of the IA flows downstream through conveyance structures to Pond B-4 and on to Pond B-5 where it is held; and
- Water held in Pond B-5 is pumped periodically (≈ 9 times per year) in batches over to Pond A-4.

North Walnut Creek water is routed through the A-Series ponds. Steps in the water collection and transfer process are summarized as follows:

- Runoff from the northern portion of the IA flows downstream into Pond A-3;
- Water is held in Pond A-3, then periodically (approximately 9 times per year) released in batches into Pond A-4; and
- After Pond A-4 is filled to roughly 50% of capacity, flows into Pond A-4 (from Ponds A-3 and B-5) are discontinued, thereby isolating the A-4 water from the rest of the pond network. A sample of the A-4 water is collected by CDPHE and, if sample results indicate water quality standards are met, the "batch" of water is discharged through the outlet works of Pond A-4. Samples are collected of the Pond A-4 discharge water, at station GS11, and the water flows on to Walnut Creek and station GS03. These batch releases from Pond A-4 occur from 6 to 12 times per year, depending on the amount of

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[1] The Pond B-5 outlet works are scheduled to be upgraded in the beginning of FY98. WWTP effluent, which normally flows to B-3 and then B-5, will be pump transferred to A-3 to keep B-5 de-watered. Stormwater flows to B-5 will be detained in B-5. This water will be periodically pump transferred to A-4 to keep the construction site dry. Once the B-5 outlet works are completed in February 1998, water will be direct batch discharged to Walnut Creek.

precipitation received at the Site, and involve approximately 100 to 200 million gallons of water annually.

As indicated above, all of the IA runoff that flows into North and South Walnut Creeks is ultimately routed through Pond A-4, detained, and sampled prior to being released to flow to Walnut Creek. There is no source of runoff from the IA that can enter Walnut Creek without first passing through the pond system and discharged at Pond A-4. Downstream from Pond A-4, the only sources of surface water to Walnut Creek before Walnut Creek passes station GS03 are from No Name Gulch, the McKay Bypass Canal, or from overland flow directly into Walnut Creek.

2.2. GS03 MONITORING RESULTS

As specified in the draft Surface Water Integrated Monitoring Plan (SW IMP), the Site's Water Management & Treatment (WM&T) group evaluates 30-day moving averages[2] for selected radionuclides at RFCA POEs and POCs. Continuous flow-paced sampling is conducted at all RFCA POEs and POCs through the use of automated flow-measurement and sampling equipment[3]. This section presents recent evaluations of water-quality measurements at POC surface-water monitoring location GS03 (see Figure 2-2) show values above the POC Standard value of 0.15 pCi/L Pu and Am. GS03 is located on Walnut Creek at Indiana Street. Results for 30-day moving averages using available data at GS03 are summarized below in Table 2-1 and are also plotted in Figure 2-3. The mean daily flow rate and available individual sample results are plotted in Figure 2-4.

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[2] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place that day). Therefore, there are 365 30-day moving averages for a location which flows all year. At locations which monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed lab analysis or NSQ for analysis, no 30-day average is reported.

[3] Through the use of a Data Quality Objectives (DQO) process, the SW IMP specifies the target number of composite samples ('carboys' receiving multiple grabs) to be collected at each monitoring location. The IMP further specifies that these carboys should be flow-paced. The flow pacing is based on the predicted stream discharge using historic record for each location. For example (for a specific location), if two carboys are targeted for a certain month, and the historic discharge volume is 100,000 gallons, then each carboy should represent 50,000 gallons. Grab samples of 200 ml are collected; smaller grabs push the repeatability limits of the auto-sampler. Since the carboys can hold 15l, and the minimum volume for analysis is ≈ 5l; the samplers are programmed to place 10l (50 grabs) in the carboy. So, for 50,000 gallons, the sampler is programmed for 1 grab per 1,000 gallons (50,000gals/50grabs). Targeting 50 grabs allows for periods of discharge greater than expected (up to 75 grabs) without having to collect additional carboys. Similarly, periods of discharge less that expected (25 grabs) may still yield enough sample for analysis.

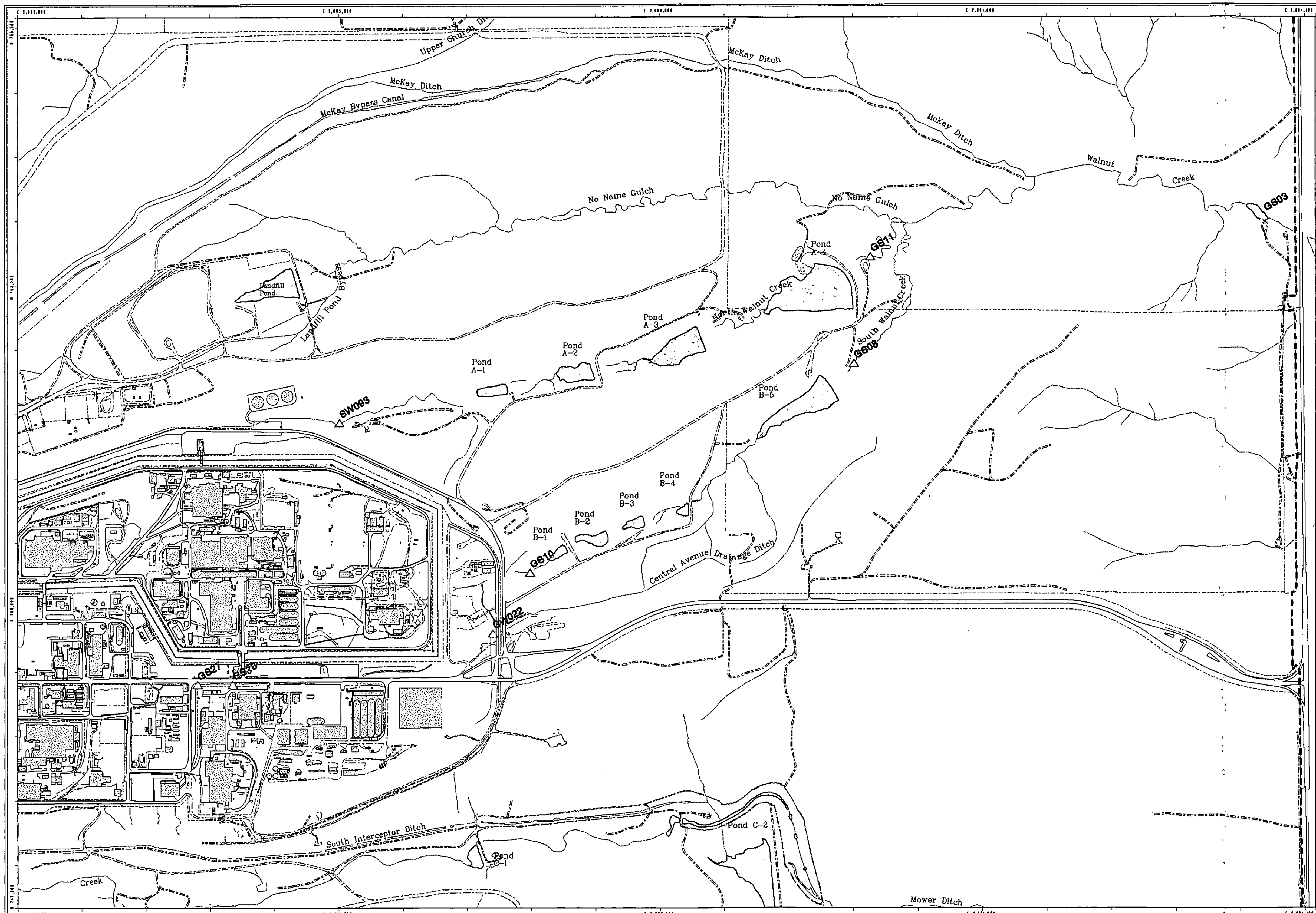

Figure 2-2

Selected Surface Water Monitoring Locations in Walnut Creek

Legend

Gaging & Sampling

△ Surface Water Monitoring Location

Standard Map Features

Buildings or other structures

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Rocky Flats boundary

Paved roads

Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95

Scale = 1 : 11610
1 inch represents approximately 968 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

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MAP ID: 97-0189-GS03 September 26, 1997

/gis2/projects/fy97/97-0189/gs03-smpl-fig2-1.aml

Table 2-1. Water-Quality Information from GS03 for the Period: 10/1/96-8/7/97.

Location	Parameter	Date(s) 30-Day Average Above 0.15 pCi/L	Date(s) of Maximum 30-Day Average	Maximum 30-Day Average (pCi/L)	Volume Weighted Average for Water Year to Date[4] (pCi/L)
GS03	Pu-239,240	6/12/97 - 7/2/97	6/13/97 - 6/24/97	0.465	0.036
GS03	Am-241	6/13/97 - 6/24/97	6/13/97 - 6/24/97	0.256	0.018

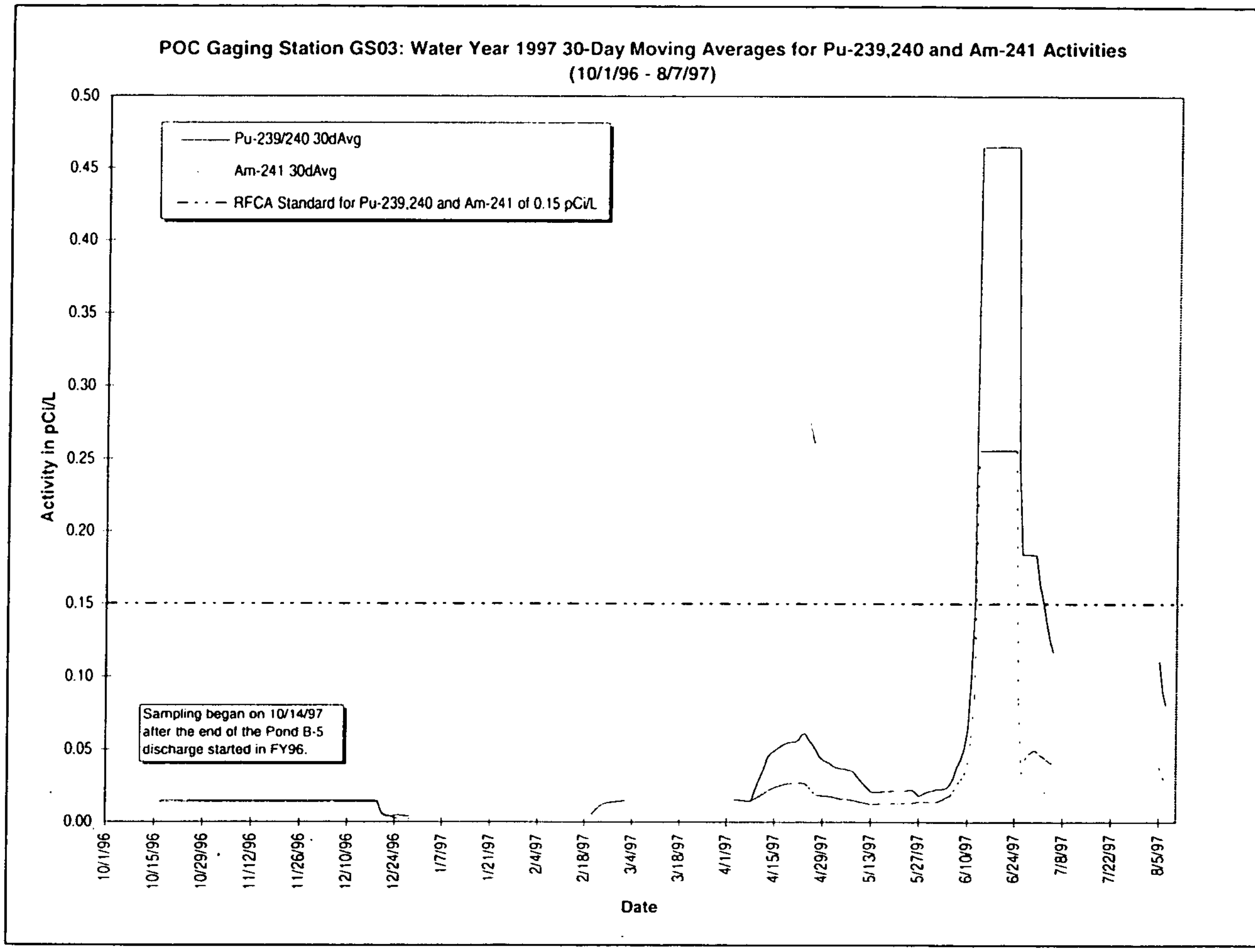

Figure 2-3. Gaging Station GS03 30-Day Averages: 10/1/96 - 8/7/97.

The individual analytical results for the composite samples collected around the period of these elevated 30-day averages have been reviewed, and there is no reason to question their accuracy. Based on past analytical results for this location, these elevated values are considered unusual, with historical measurements being

[4] A water year (abbreviated as WY) is defined as the period October 1 through September 30.

well below 0.05 pCi/L [5]. Samples collected after the period of elevated measurements showed normal Pu and Am activities. Individual composite sample results and detail are shown in Table 2-2 for the period of interest.

The composite sample at GS03 for the period 5/15/97 - 6/25/97 was collected during baseflow conditions between Pond A-4 (the terminal pond for North Walnut Creek) discharges. It should be noted that this is a low volume sample (NSQ[6]; see Section 6.2.1), radio-analytical protocol recommends a minimum sample volume of 4 liters to produce accurate radio-analytical results. The two composite samples at GS03 for the period 6/25/97 - 7/1/97 were collected as the first 2-of-3 composites during a Pond A-4 discharge (See Table 2-3 for Summary of Pond Discharges from April through September 1997). Analytical results for composite samples from POC gaging station GS11 (Figure 2-2), which monitors controlled discharges from Pond A-4, show no elevated readings for Pu-239,240 or Am-241 for the discharges which occurred during the period of elevated measurements at GS03. Table 2-4 and Figure 2-5 summarizes these results.

Table 2-2. Selected Composite Sample Analytical Results for GS03.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
4/8 - 4/13/97	0.220	0.045	0.059	0.064	1.2[a]	5.31
5/15 -6/25/97[b]	0.465	0.129	0.256	0.116	1.0	0.34
6/25 - 6/27/97	0.165[c]	0.052	0.018	0.021	8.0	2.83
6/27 - 7/1/97	0.184	0.046	0.056	0.036	8.6	5.37
7/1 - 7/6/97	0.000[d]	0.006	0.024	0.022	8.4	4.11
8/5 - 8/8/97[e]	0.002	0.011	0.002	0.023	17.4	5.42

[a] Low sample volume (1.2 liter) due to frozen sampler lines; this sample did not give a 30-day Pu average above 0.15 pCi/L.
[b] Low sample volume (1 liter) due to dry weather and associated low flows.
[c] This is an arithmetic average for values of the first analytical run (0.206 pCi/L) and a rerun (0.124 pCi/L); error is the arithmetic average error
[d] Actual result was -0.004 pCi/L for this sample; result is set to zero for practical reporting and calculation purposes.
[e] During the period from 7/6/97 - 8/5/97, the sampler collected an insufficient quantity for analysis due to unanticipated low flow rates.

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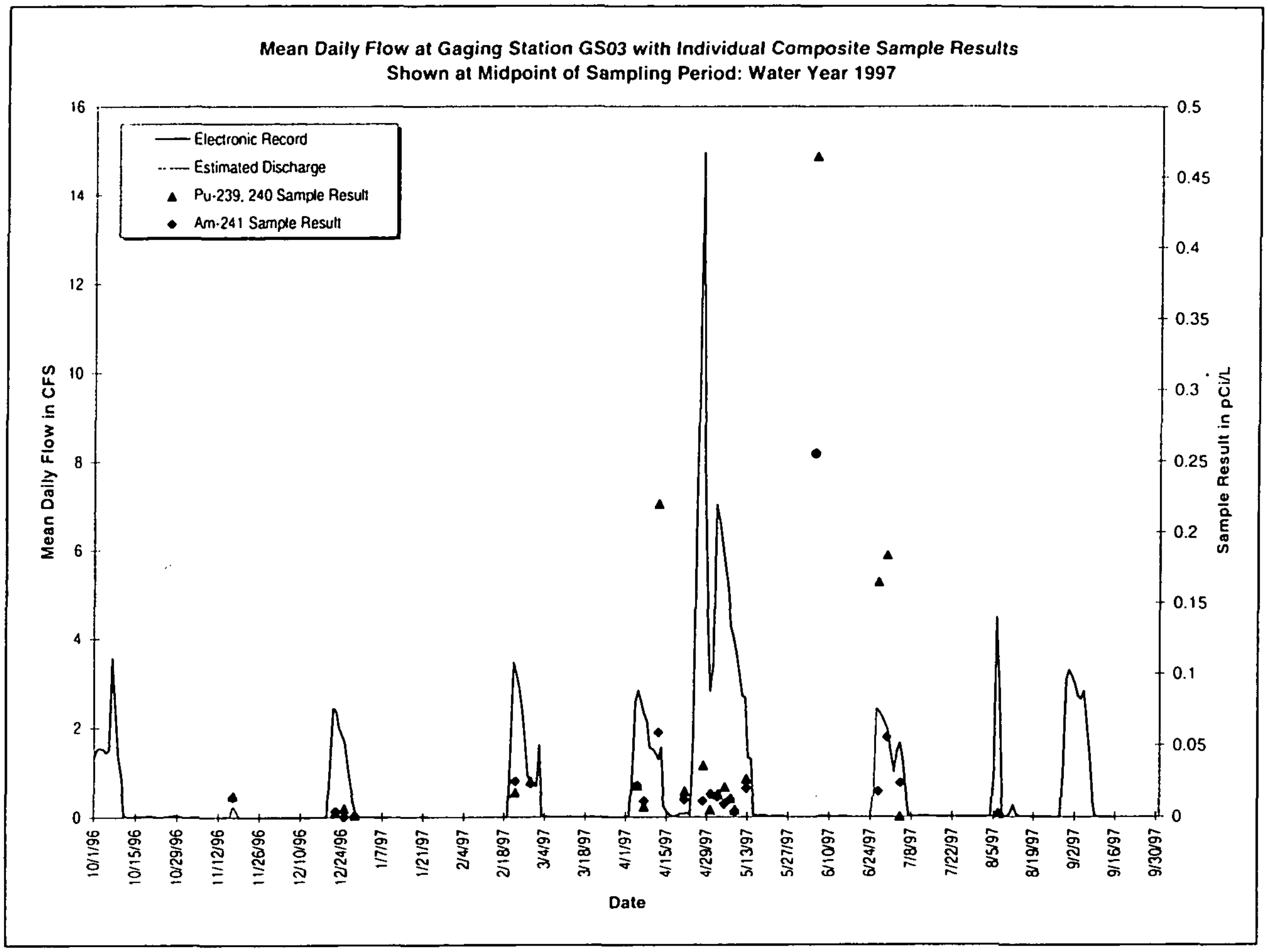
[5] Historical values are available in the Site Annual Environmental Reports and the Quarterly Environmental Monitoring Reports. Detailed information is also presented in Section 3.2.

[6] For situations where non-sufficient quantity (NSQ) is collected for analysis, either due to equipment failures or exceptionally low streamflows, the SW IMP specifies that the sample may be discarded. NSQ for GS03 occurs occasionally for baseflow periods. At GS03, the SW IMP targets 1 carboy for the periods of baseflow between Terminal pond discharges. The SW IMP further specifies that the carboy must represent only baseflow, and must be removed from the sampler at the beginning of a Terminal pond discharge. Therefore, if flows significantly less than predicted are measured at GS03, the flow-paced carboy may not receive sufficient volume for analysis before it must be removed from the sampler.

The results indicate that water discharged from the Site's Terminal Ponds is not the source of the elevated measurements at GS03. This information suggests that the source of the Pu and Am measured at GS03 is downstream of the Terminal Ponds or located in a tributary to Walnut Creek in the Terminal Pond-to-GS03 stream reach. This area has no known sources of significant contamination. For reference, Figure 2-1 shows the hydrologic routing for drainages and water management facilities which are related to GS03.



Intermittent peaks are from Terminal Pond A-4 and B-5 discharges; runoff peak (≈ 4/24 - 4/28) is from large snowmelt event. Sampling began on 10/14/97 after the completion of a B-5 discharge. Samples shown where data has been received form analytical labs (10/14/97 - 8/7/97).

Figure 2-4. Gaging Station GS03 Hydrograph and Sample Results.

Table 2-3. Summary of Discharges for 4/3/97-9/8/97.

Location	Discharge Dates	Volume Discharged (gal)
Pond A-4	4/3/97 - 4/13/97	13,609,000
Pond B-5	4/28/97 - 5/12/97	15,450,000
Pond A-4	5/1/97 - 5/14/97	25,616,000
Pond A-4	6/25/97 - 7/6/97	13,319,000
Pond A-4	8/5/97 - 8/7/97	4,250,000
Pond A-4	8/29/97 - 9/8/97	17,916,000

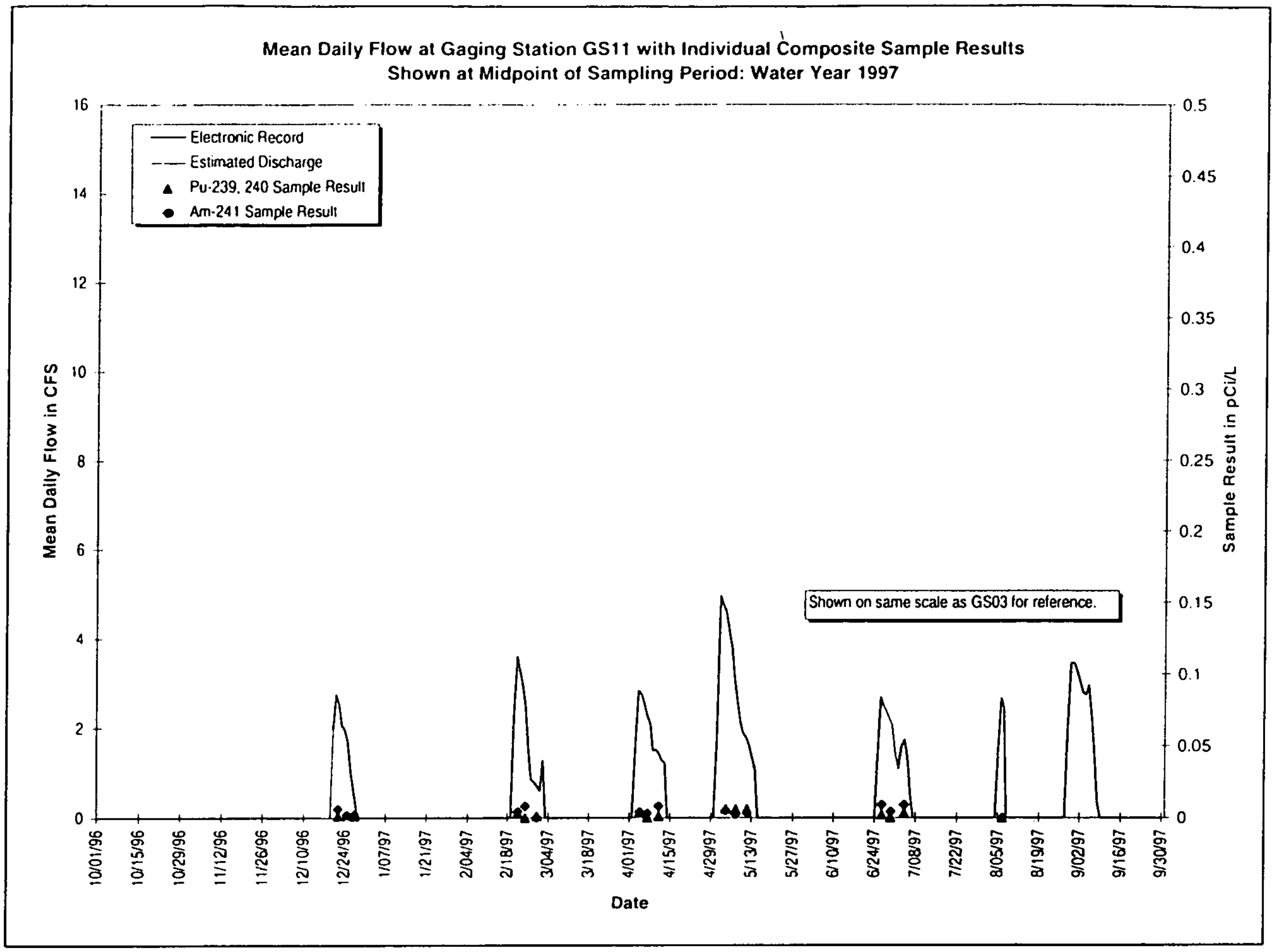
Table 2-4. Selected Composite Sample Analytical Results for GS11.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	Pond A-4 Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
4/8 - 4/13/97	0.001	0.005	0.008	0.012	8.2	4.98
5/1 - 5/6/97	0.006	0.004	0.005	0.007	17.4	14.61
5/6 - 5/8/97	0.006	0.005	0.002	0.006	6.8	3.85
5/8 - 5/14/97	0.006	0.004	0.003	0.005	10.6	7.16
6/25 - 6/27/97	0.002	0.005	0.009	0.011	9.4	3.42
6/27 - 7/1/97	0.000[a]	0.012	0.004	0.017	4	5.67
7/1 - 7/6/97	0.003	0.012	0.009	0.012	7.8	4.22
8/5 - 8/7/97	0.000[b]	0.008	0.000	0.013	13.8	4.25

[a] Actual result was -0.009 pCi/L for this sample; result is set to zero for practical reporting and calculation purposes.

[b] Actual result was -0.008 pCi/L for this sample; result is set to zero for practical reporting and calculation purposes.

During the time period of 4/3/97 - 9/8/97, no off-normal conditions were noted in either decontamination and decommissioning (D&D), special nuclear material (SNM) stabilization, or environmental restoration (ER) activities that may have affected water quality, nor were there any closure activities occurring in the Walnut Creek drainage between Pond A-4 and Indiana Street. An initial walk-down of the Walnut Creek drainage between GS03 and Pond A-4 was conducted on August 15, 1997 and revealed no unusual conditions which might provide insight into elevated radionuclides in surface water for the May-July timeframe. Immediately downstream of station GS03 the water flowed offsite and was diverted around Great Western Reservoir, thus the downstream effect cannot be quantified. Pond A-4 discharges during this period showed normally low Pu and Am levels (as shown in Table 2-4).



Samples shown where data has been received form analytical labs (10/1/97 - 8/7/97).

Figure 2-5. Gaging Station GS11 Hydrograph and Sample Results.

2.3. GS10 MONITORING RESULTS

As specified in the draft SW IMP, the Site's WM&T group evaluates 30-day moving averages[2] for selected radionuclides at gaging station GS10. GS10 receives flow from the central IA and monitors flow to South Walnut Creek via the B-1 bypass pipeline to Pond B-4 which flows into Pond B-5. Recent evaluations of water-quality measurements at POE surface-water monitoring location GS10 (located on South Walnut Creek just above Pond B-1 as shown on Figure 2-2) show values above 0.15 pCi/L for Pu and Am. Results for 30-day moving averages using available data at GS10 are summarized below in Table 2-5and are shown on Figure 2-6.

The analytical results for the composite samples collected around the period have been verified. A review of historical monitoring data shows that these results are not unusual. Storm-event samples collected at GS10 from 1992 through 1996 (under pre-RFCA protocols) had an arithmetic average Pu-239,240 activity of 0.23

pCi/L with a maximum of 1.4 pCi/L. The apparent trend upward during WY97 is likely due to seasonally increasing flow rates which carry increased suspended material. To the best of the Site's knowledge, no off-normal conditions were experienced at any D&D, SNM stabilization, or environmental cleanup activities during this time period that could have affected water quality.

Table 2-5. Water-Quality Information from GS10 for the Period: 10/1/96-7/7/97.

Location	Parameter	Date(s) 30-Day Average Above 0.15 pCi/L	Date(s) of Maximum 30-Day Average	Maximum 30-Day Average (pCi/L)	Volume Weighted Average for Water Year to Date (pCi/L)
GS10	Pu-239,240	4/13/97 - 4/24/97 5/25/97 - 6/20/97	6/5/97	0.262	0.116
GS10	Am-241	5/25/97 - 6/14/97	6/5/97	0.215	0.09

Samples shown where data has been received form analytical labs (10/1/97 - 7/7/97).

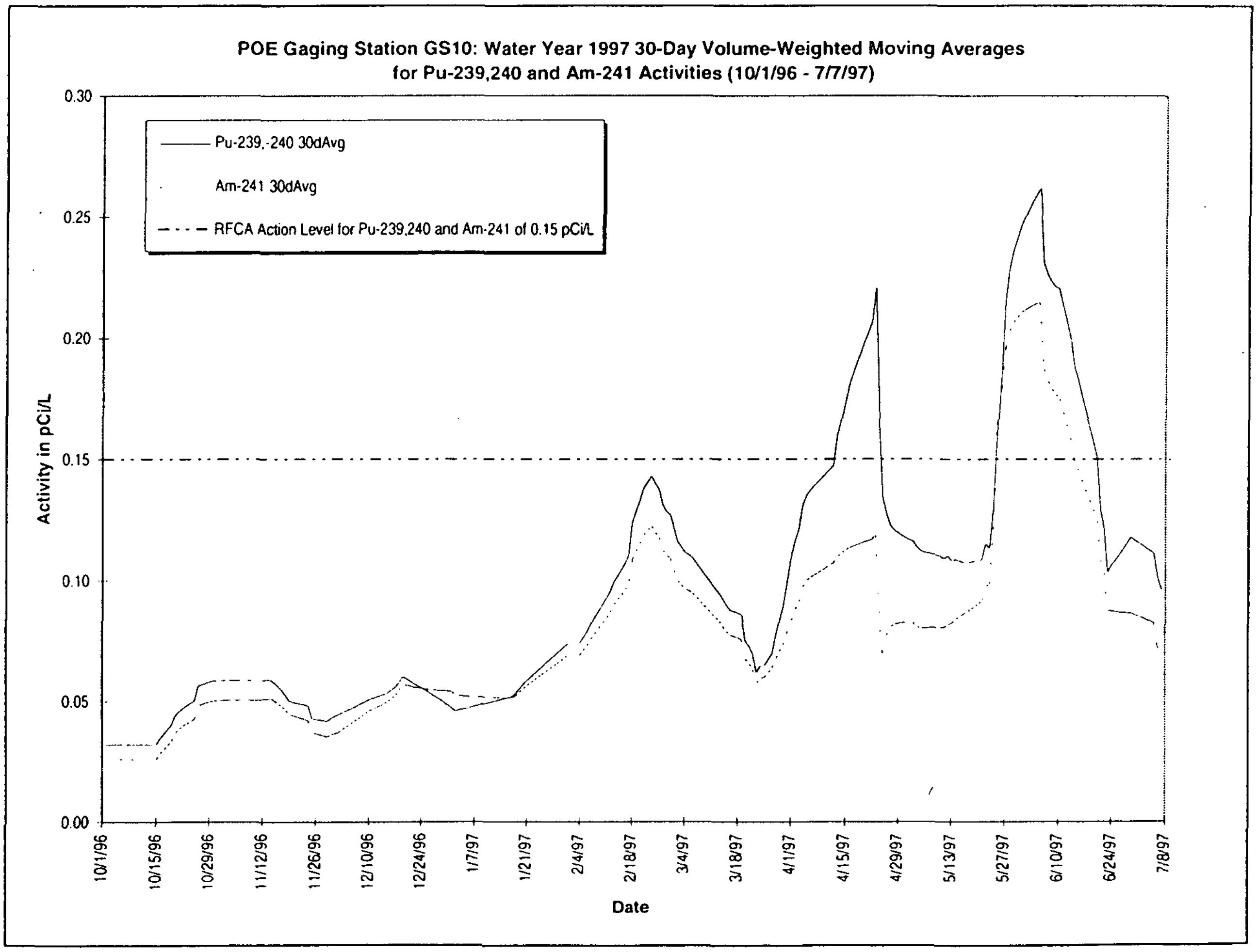


Figure 2-6. Gaging Station GS10 30-Day Averages: 10/1/96 - 7/7/97.

All water monitored at GS10 subsequently flowed to Pond B-5 and was transferred to Pond A-4, and Pond A-4 was subsequently discharged to Walnut Creek. Pre-discharge samples of the water in Pond A-4 indicated acceptable water quality for all discharges. Analytical results from composite samples collected at gaging station GS11 at the Pond A-4 outfall during each discharge were well below the RFCA standard (see Table 2-4). This improvement in water-quality indicates that the Site's water-management practices help mitigate contamination. Individual composite sample results and detail for GS10 are shown in Table 2-6 for the period of interest.

Table 2-6. Composite Sample Analytical Results for GS10: 3/28/97 - 6/8/97.

Composite Sample Period	Pu-239,240 (pCi/L)		Am-241 (pCi/L)		Composite Sample Volume (Liters)	S. Walnut Cr. Discharge Volume During Sample Period (Million Gallons)
	Result	Error	Result	Error		
3/28/97 - 4/2/97	0.300	0.026	0.140	0.015	6	0.29
4/2/97 - 4/11/97	0.150	0.017	0.110	0.021	8.8	1.37
4/11/97 - 4/24/97	0.410	0.041	0.140	0.019	12.2	2.36
4/24/97 - 4/25/97	0.086	0.014	0.045	0.009	12.8	1.64
4/25/97 - 4/26/97	0.070	0.012	0.033	0.009	10.8	2.39
4/26/97 - 5/12/97	0.086	0.014	0.120	0.017	4	2.67
5/12/97 - 5/25/97	0.380	0.049	0.300	0.044	7.4	1.19
5/25/97 - 6/8/97	0.134	0.043	0.106	0.053	9.6	1.66

3. DATA SUMMARY AND ANALYSIS FOR GS03

All IA runoff and Wastewater Treatment Plant (WWTP) effluent tributary to Walnut Creek passes through the Terminal Ponds A-4 and B-5. Since discharges from A-4 (GS11) showed no elevated activities during the period of elevated activities at GS03 (as discussed in Section 2), it is assumed that source of the radionuclide activity at GS03 is downstream from the Terminal Ponds. Therefore, the following section primarily includes analysis and interpretation of environmental information for the GS03 drainage from the Site Terminal Ponds to Indiana Street, including tributaries. However, an evaluation of significant Site projects during the period of concern is included, regardless of hydrologic connection. The origin (dates and location) of all included information is presented, and summary statistics are calculated. The significance of each type of information and conclusions which may be drawn are presented. A cross-linked discussion of this information and the specific source location hypotheses they support or do not support is included in Section 5.

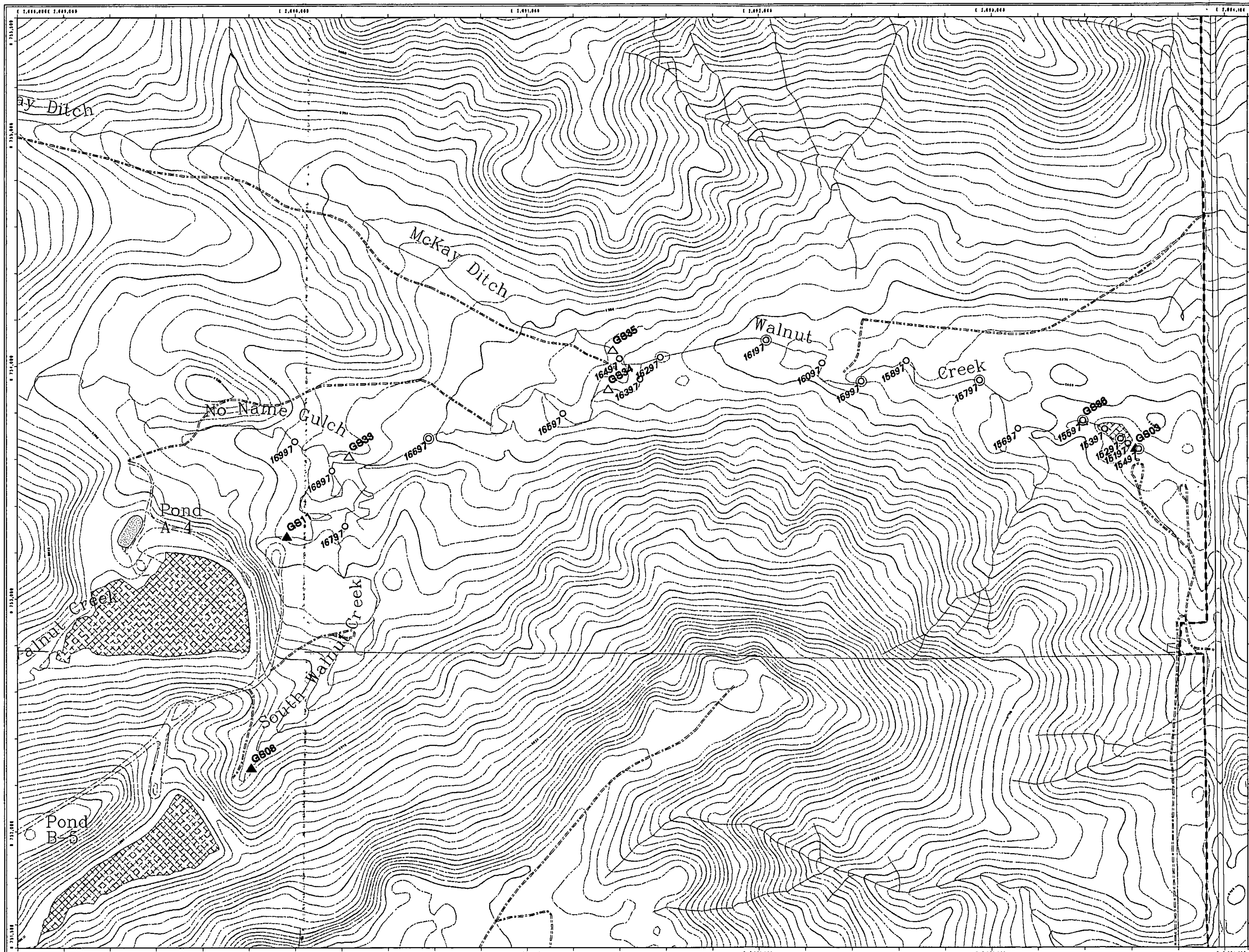


Figure 3-1

GS03 Drainage Area with Selected Sampling Locations
(Lower Walnut Creek)

August 1997

Legend

Gaging & Sampling

- ▲ Gaging Station (Point of Compliance)
- △ New Gaging Station Location
- ○ Sediment Sampling Location (Location Code Shown, Aug. 21, 1997)
- ○ Synoptic Sampling Location (Aug. 29 - Aug. 30, 1997)

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was capture by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution.
The DEM post-processing perfromed by MK, Winter 1997.

N

Scale = 1 : 5530
1 inch represents approximately 461 feet

100 0 200 400 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
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P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0188-GS03 September 29, 1997

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3.1. WALK-DOWN OF DRAINAGE AREA

In response to the report of elevated levels of Pu and Am at GS03 on August 15, 1997, a walk-down was performed of the drainage area leading to Walnut Creek and Indiana Street. Specifically, the walk-down started at the Pond A-4 outlet, where the discharge had shown normally low levels of Pu and Am, and covered the stream reach to GS03. The purpose of the walk-down was to visually identify conditions which may have indicated source areas contributing to the elevated readings. Conditions which might indicate a potential source area include the following items:

- Existence of man-made materials in drainage pathways;
- Areas of concentrated fine sediments in drainage pathways;
- Areas which contribute significant quantities of runoff sediment (e.g., steep dirt roads, barren hillsides, and slopes needing revegetation);
- Erosion on radionuclide-related Individual Hazardous Substance Sites (IHSSs);
- Position of radionuclide-related IHSSs in relation to storm water drainage pathways; and
- Overall condition of storm drainage pathways.

The walk-down revealed no evidence of any man-made materials in the drainage pathways. Several areas exhibited signs of recent high flows, which were measured at GS03 of up to 7 cubic feet per second(cfs) for the period 8/5/97 - 8/7/97. Flows were large enough to breach stream banks, and in some locations vegetation was matted down. Coarse sediment (small rocks and gravel) had been deposited on top of grassy areas. Fine sediments were concentrated in areas where the flow shifted direction or slowed in velocity. The erosion of the channel was typical of a "washout" that occurs during infrequent periods of very high flows. The walls of the channel were sloughed off and the banks cut away at the switchbacks. Surrounding dirt roads and hillsides showed signs of recent heavy rains, but the vegetation appeared to prevent significant contribution of sediment to the drainage. There was no evidence of channelized seeps, which would indicate significant contribution of groundwater to surface water. In addition, observation of known radionuclide-related IHSSs in the drainage area showed no disturbances or signs of recent work activity.

The elevated results at GS03 were measured before the heavy rains and high flow rates which likely created the conditions noted above. However, it is important to note that these types of flows and erosion mechanisms do occur in Walnut Creek, and can result in actinide transport.

An additional walk-down of Walnut Creek was performed on August 20, 1997, and included No Name Gulch, a tributary to Walnut Creek. Nothing unusual was observed that may have indicated a potential source of contamination. Movement of the sediments and erosion of the No Name Gulch was typical of infrequent high flows, as noted for Walnut Creek. Baseflow was noted in Walnut Creek coming from the flume pond just above GS03, but there was no inflow. This indicates that interflow or groundwater is entering the pond, possibly through contaminated sediments. Similarly, sections of Walnut Creek showed standing or barely flowing stretches of water with intermittent stretches of dryness. This is again indicative of interflow in the creek bottom matrix and/or groundwater interaction.

3.2. AUTOMATED SURFACE-WATER MONITORING DATA

This section presents data summary and analysis for environmental information collected at gaging stations GS03 (Walnut Creek at Indiana Street), GS08, and GS11 (the Terminal Ponds in Walnut Creek). Data presented includes flow rates, discharge volumes, radionuclide activities, radionuclide loads, water-quality parameters, and precipitation. Analysis is performed on averages of all data available from Water Year 1993 to present, the continuous flow-paced samples from WY97, and the specific periods of recent elevated measurements[7]. Although both Pu and Am were elevated at GS03, this section focuses on the transport and source location for Pu only. Analysis for both Pu and Am will be included in Progress Report #3 when assessing any downstream effects and risks associated with the increased transport of actinides.

3.2.1. Data Summary

Significant data exists for flow and radionuclide activities at the gaging stations of interest. Information for total suspended solids (TSS), metals, major ions, etc. is limited. Additional information for these parameters will need to be collected should the progress of the source evaluation indicate the need.

Surface Water Flow Rates and Discharge Volumes

A reliable flow record has been collected at GS03, GS08, and GS11 since WY93. Site Terminal Pond discharges to Walnut Creek represent an average of 70% of the volume annually measured at GS03. However, this average is highly influenced by the very high runoff volumes in WY97. Variation of flow rates and discharge volumes is significant in Walnut Creek, and coincides with variation in precipitation (as shown on Figure 3-2 and Figure 3-3). Significant gains in flow rates are seen at GS03 for the Spring months as overland flow occurs in the drainage between the Terminal Ponds and GS03. Additionally, tributaries and seeps contribute relatively more water during these months.

[7] Flow data is included for the period 10/1/92 - 9/15/97; analytical data is included for the period from 10/1/92 - 8/7/97.

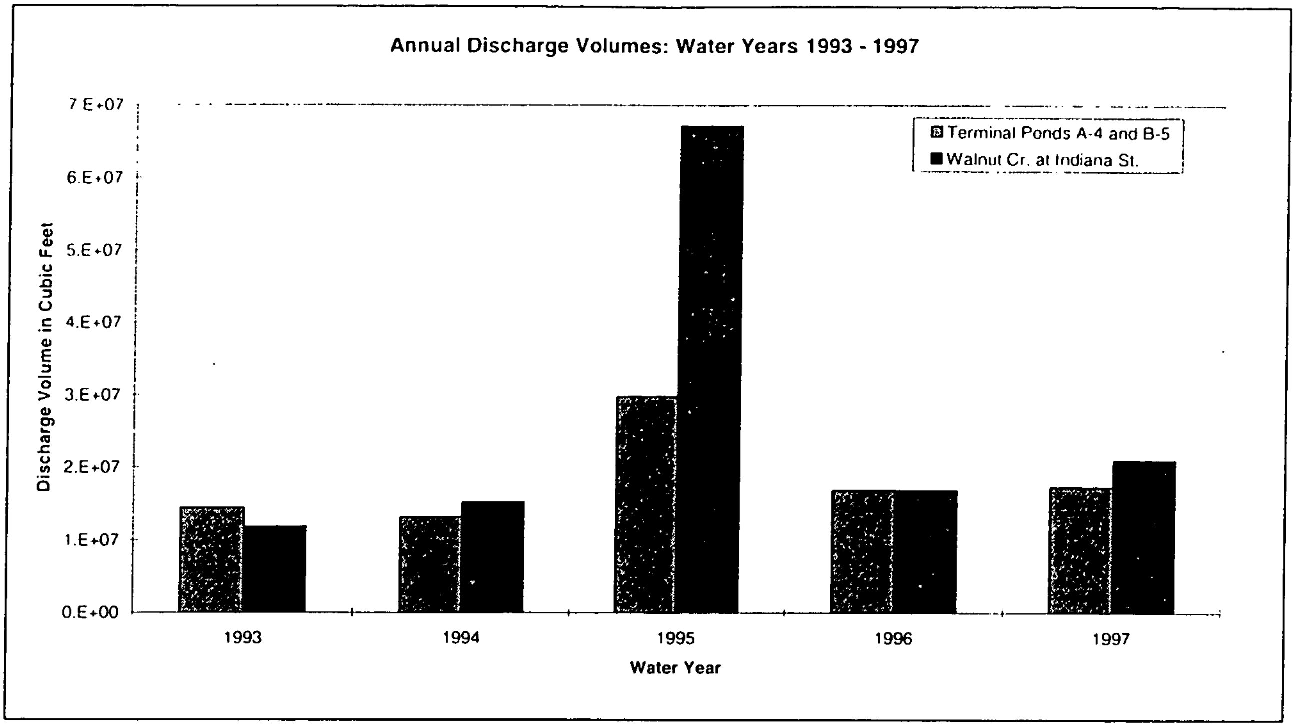

Figure 3-2. Annual Discharge Volumes for Walnut Creek.

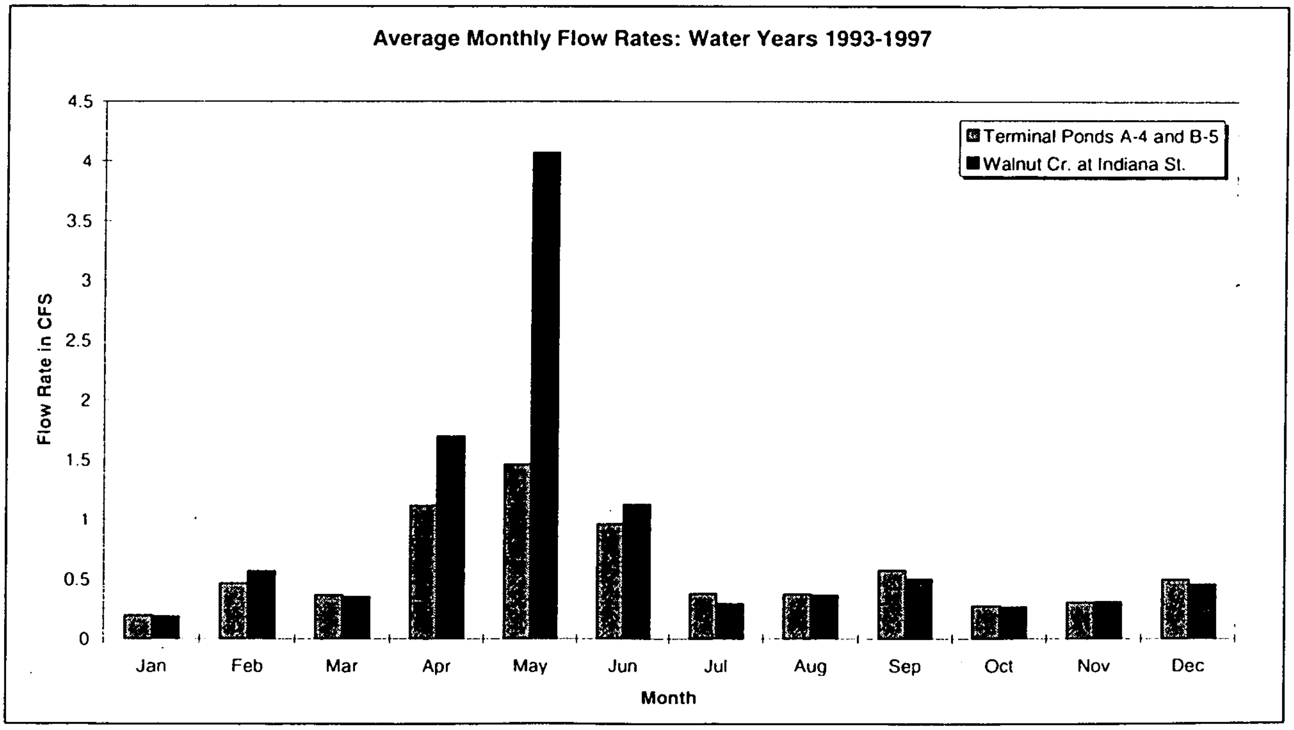

Figure 3-3. Average Monthly Flow Rates in Walnut Creek.

Radionuclide Activities

Individual analytical results for Pu are shown in Figure 3-4. The higher values in WY95 were a result of very high runoff volumes and the subsequent emergency discharge of Ponds A-4 and B-5 before adequate settling of contaminants could be achieved. All sample results are plotted regardless of sampling protocol employed[8]. The recent elevated results at GS03 can be seen on the right side of the plot. The unusual magnitude of these measurements is apparent. Summary statistics for these results are shown in Table 3-1. These summary statistics indicate that there may be a decrease in water quality between the Terminal Ponds and Indiana Street. However, it should be noted that these activities are arithmetic averages, which do not take into account the hydrologic conditions during sampling (storm-event, baseflow, etc.) or the flow rate (more importantly, the discharge volume) associated with the measured activity.

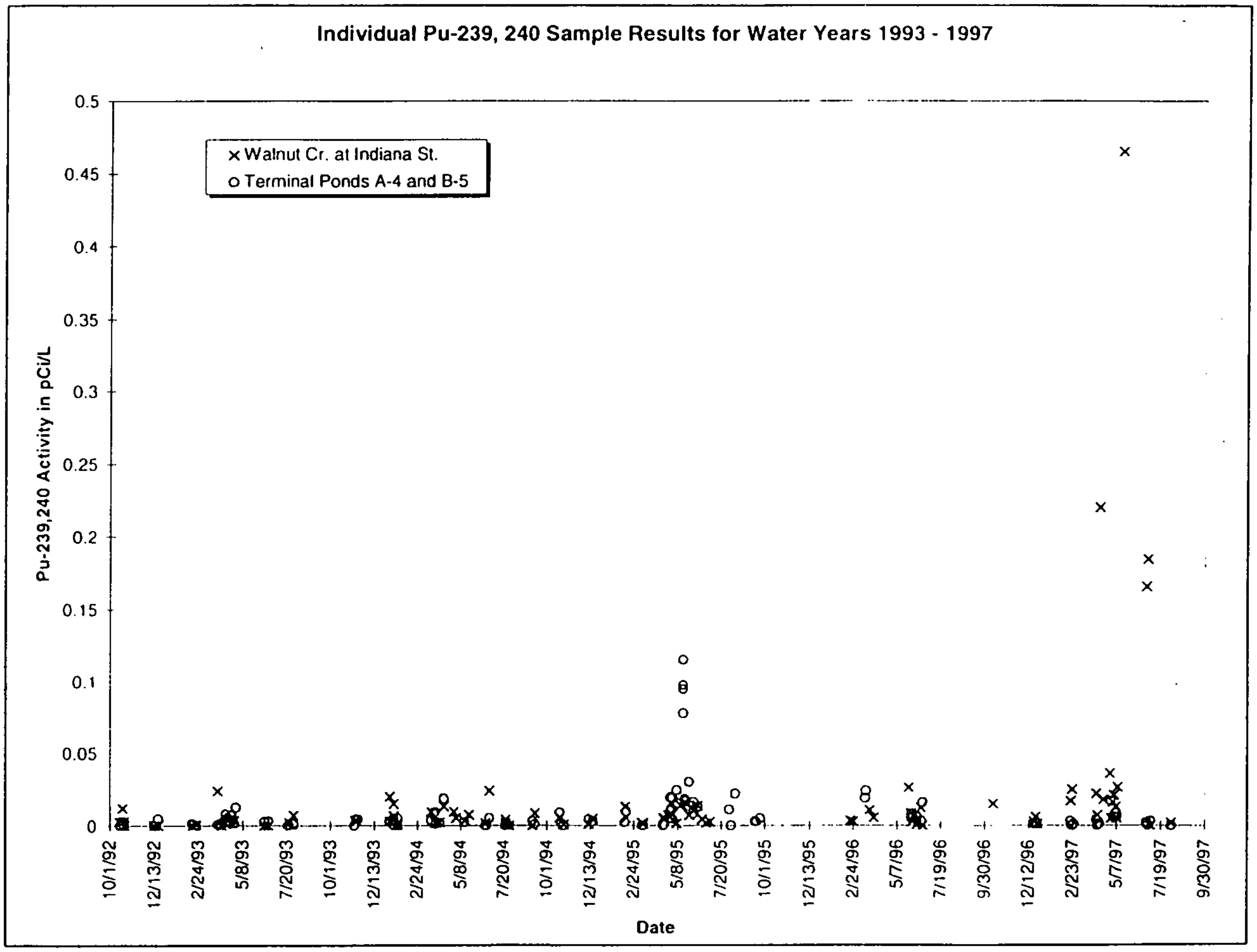

Figure 3-4. Individual Analytical Pu Results for Walnut Creek.

[8] Individual grabs, time-paced (scheduled grabs) composites, storm-event (hydrograph rising limb) flow-paced composites, and continuous flow-paced composites are shown. For a discussion of sample collection methods, see Section 6.2.4.

Table 3-1. Summary Statistics for Samples from Pond A-4, Pond B-5, and Walnut Creek at Indiana Street.

Sampling Location[a]	Number of Samples	Average[b] Activity (pCi/L)	Maximum Result (pCi/L)	Standard Deviation[c] (pCi/L)
Walnut Creek at Indiana Street				
GS03	25	0.052	0.465	0.105
W+I	68	0.006	0.026	0.006
All	93	0.018	0.465	0.058
Pond A-4				
GS11	20	0.002	0.006	0.002
A4EFF	72	0.007	0.097	0.016
All	92	0.006	0.097	0.014
Pond B-5				
GS08	3	0.010	0.017	0.006
B5Eff	18	0.023	0.115	0.028
All	21	0.021	0.115	0.027

[a] Rocky Flats Environmental Database System location codes are shown; GS03 and W+I are co-located; GS11 and A4EFF are co-located; GS08 and B5EFF are co-located.
[b] Arithmetic average
[c] Assumes normal distribution

Figure 3-5 shows the relative average annual activities in Walnut Creek for WY93 - WY97. For WY93 - WY96, arithmetic averages are plotted. However, due to the continuous flow-paced sampling protocols currently in place, more representative volume-weighted average activities are shown for WY97. This volume-weighted average is calculated in a fashion similar to 30-day averages[2], except that the period is from 10/1/96 to 8/7/97.[9] It is important to note that although elevated measurements were made this year, the volume-weighted average is still below 0.05 pCi/L (0.036 pCi/L). Although average activities seem to have changed significantly, the changes are small when taken in context with the levels of activity (to less than 1/100th of a pCi). In fact, the apparent change in activity may be due to the change in sampling

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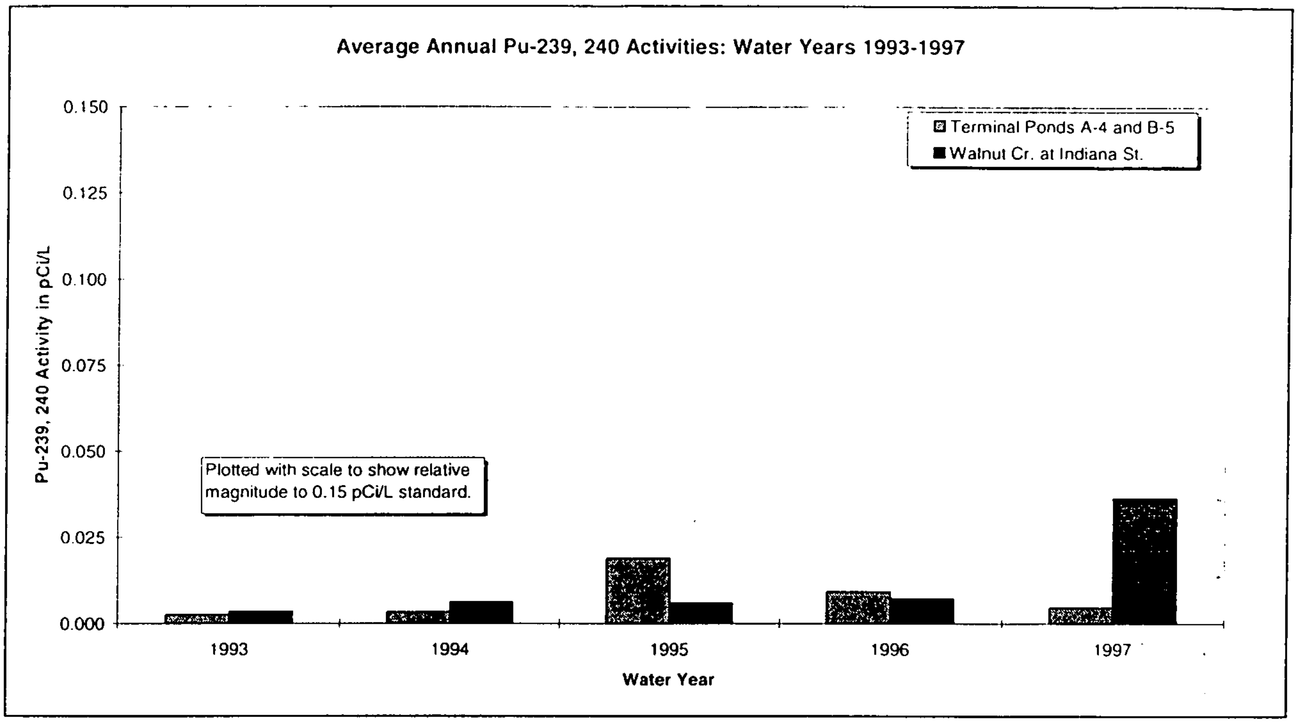
[9] Each carboy has a load in pCi calculated from the activity and the associated creek discharge volume. The total load in pCi for all samples is then divided by the total creek discharge volume to give the volume-weighted activity in pCi/L. For periods where no activity was available for GS03 (NSQ), these periods were assigned the volume-weighted average activity of the non-NSQ periods. This allows for the calculation of loads for the entire period.

protocols, and not a reflection of actual changes in the drainage. This change in sampling protocols, from grab and storm-event sampling to continuous flow-paced sampling, is discusses further in Section 6.2.4.



Volume-weighted WY97 average is plotted.

Figure 3-5. Average Annual Pu Activities for Walnut Creek.

It is generally agreed that Pu tends to form strong associations with particulate matter. If these particles are transported in surface water, then so is Pu, as shown in Figure 3-6 by the data collected at GS10. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks, generally result in increased TSS values due to higher flow velocity and turbulence. Figure 3-7 shows monthly arithmetic average activities which increase for months with higher rainfall and flow rates which are shown on Figure 3-3.

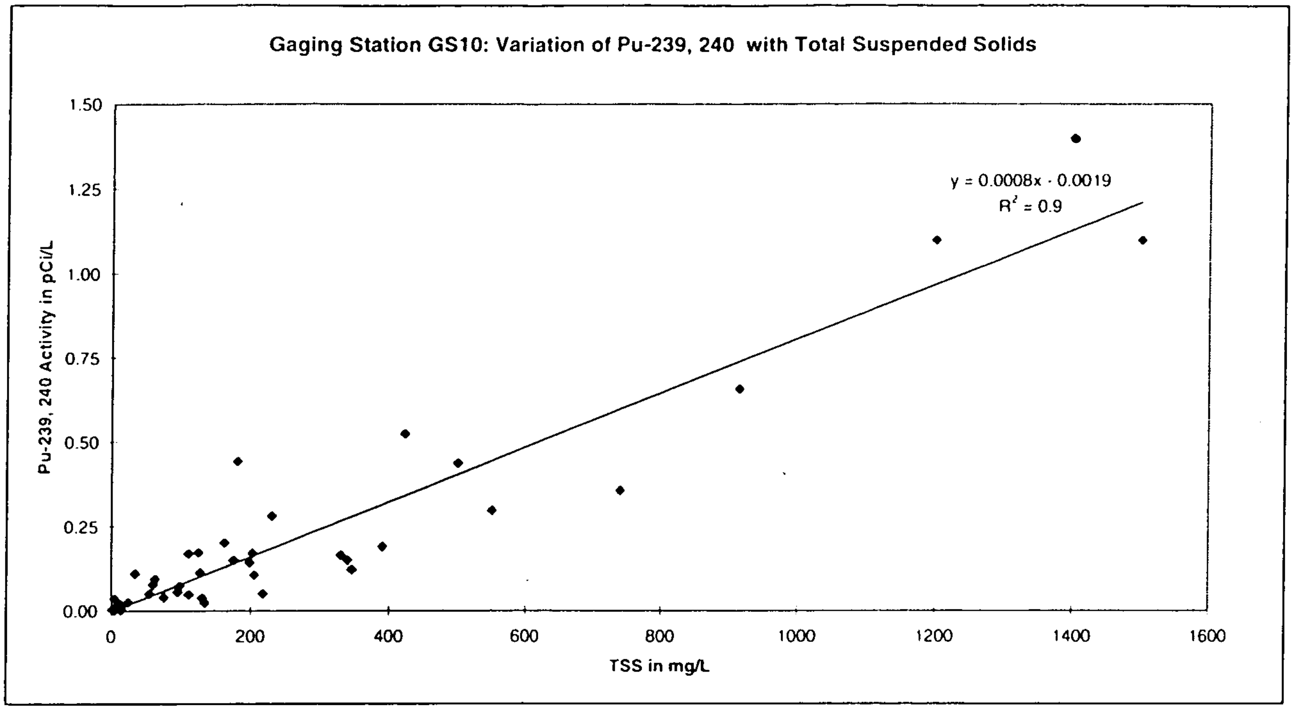
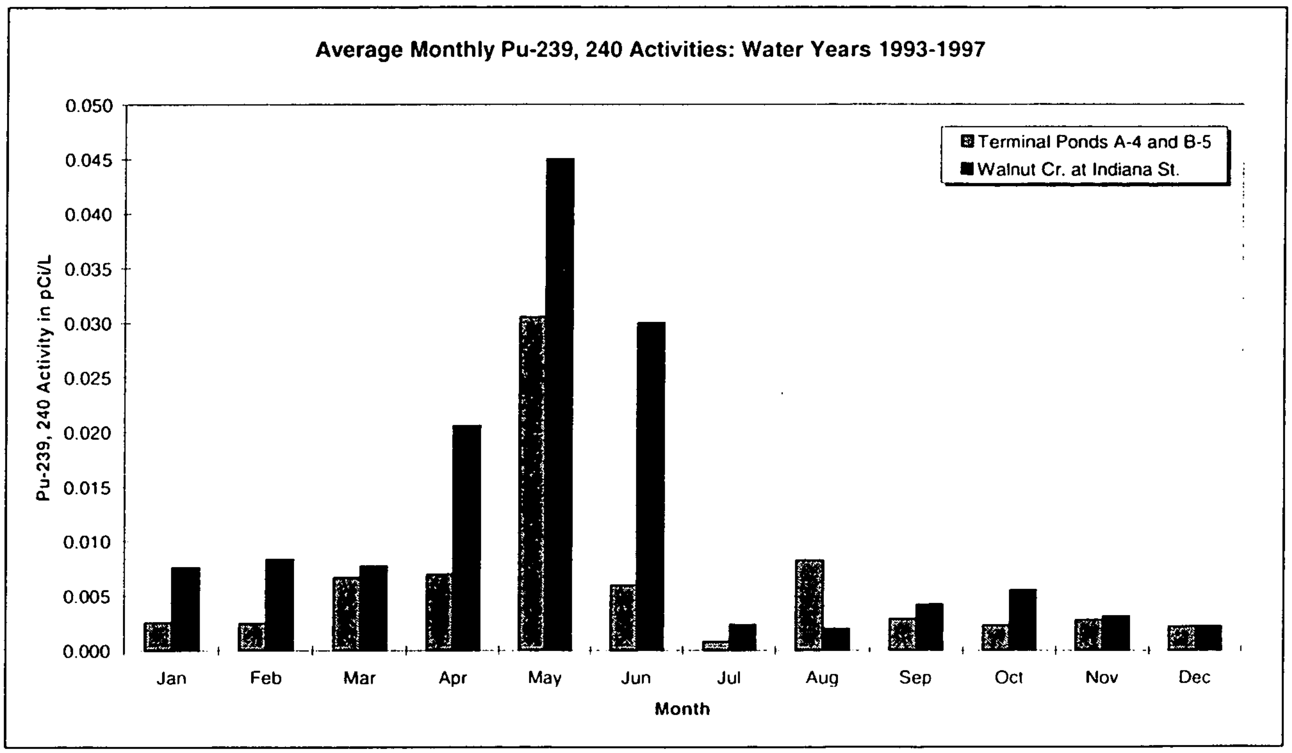


Figure 3-6. Variation of Pu with Total Suspended Solids at GS10.



All averages are arithmetic.

Figure 3-7. Average Monthly Pu Activities in Walnut Creek.

3.2.2. Loading Analysis

WY93 - WY97 Monitoring Data

Annual loads in micrograms are plotted in Figure 3-8. For WY93 - WY96, the arithmetic average activity is multiplied by the associated total annual discharge volume, then converted to micrograms. For WY97, the activity for each flow-paced composite is multiplied by the associated discharge volume, then converted to micrograms and totaled.

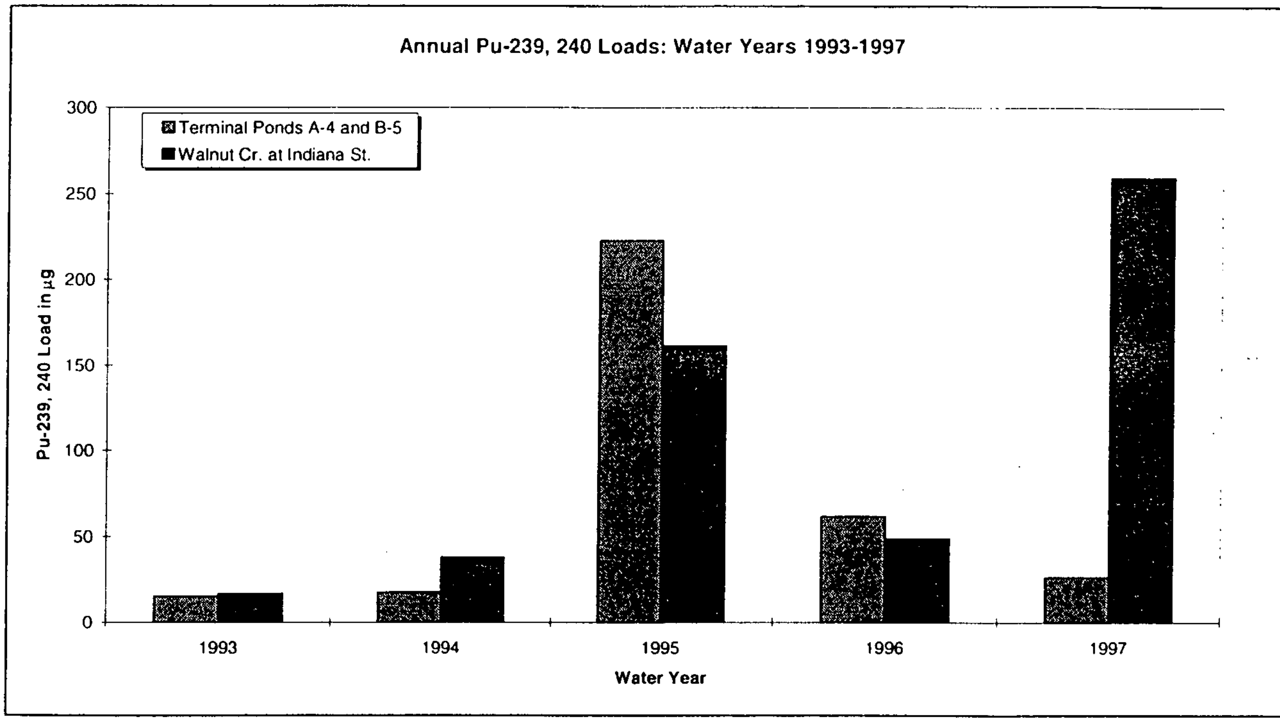


Figure 3-8. Annual Pu Loads in Walnut Creek.

The annual gain in Pu load between the Terminal Ponds and Indiana Street is plotted in Figure 3-9. Losses in load are plotted as negative values. A gain indicates that Pu entered the stream reach between the Terminal Ponds and Indiana Street. A loss indicates that either Pu was lost to the streambed, and/or that overland flow entering the reach diluted the water from the Terminal Ponds. In other words, the activity of the Terminal Pond water was greater than that of the runoff in the drainage below the Ponds (Figure 3-5). The result for WY97 indicates that a source exists in the reach below the Terminal Ponds.

Seasonal loads in micrograms are plotted in Figure 3-10. For all water years, the seasonal arithmetic average activity is multiplied by the associated average seasonal discharge volume, then converted to micrograms.

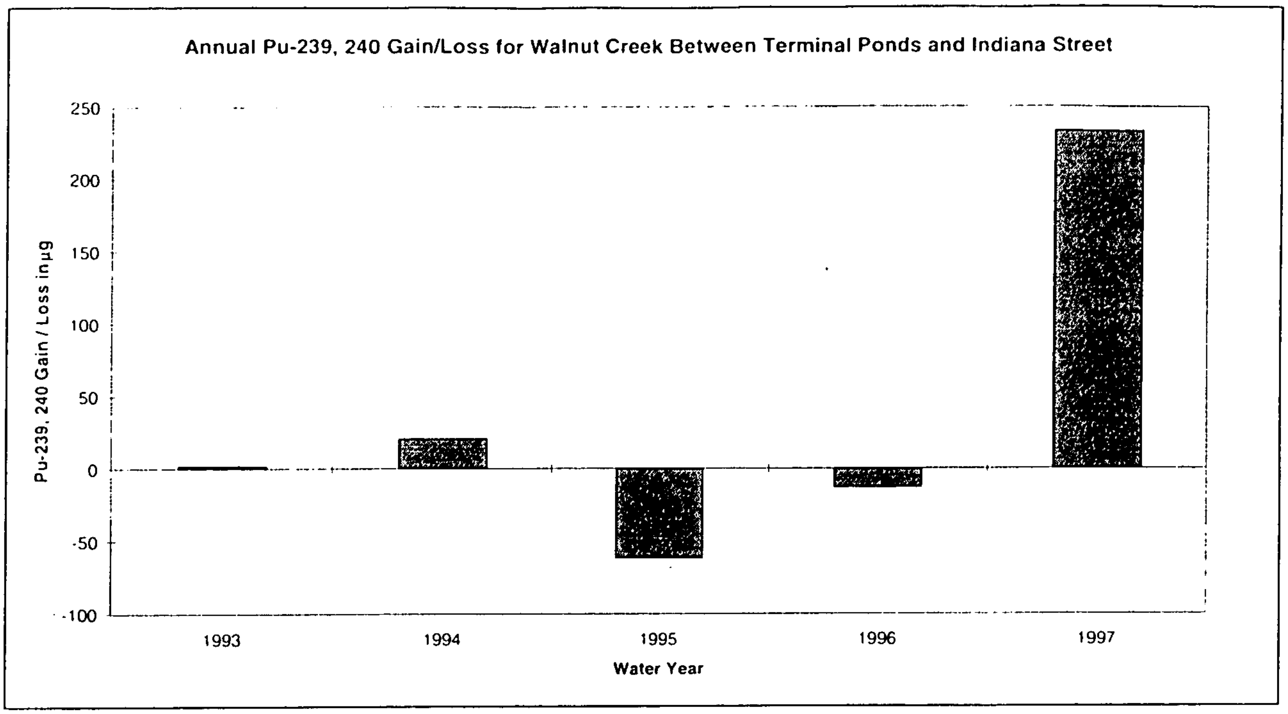


Figure 3-9. Annual Gain/Loss of Pu for Walnut Creek.

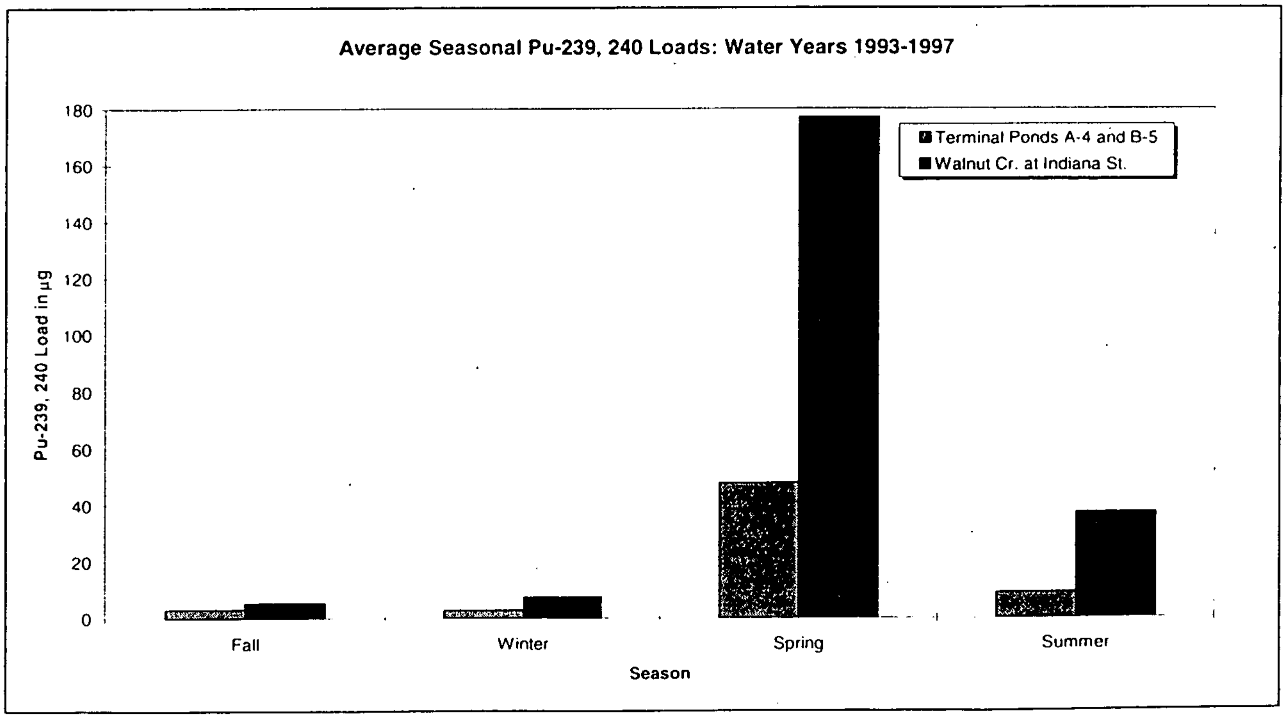


Figure 3-10. Seasonal Pu Loads in Walnut Creek.

The seasonal gain in Pu load between the Terminal Ponds and Indiana Street is plotted in Figure 3-11. A gain indicates that Pu entered the stream reach between the Terminal Ponds and Indiana Street. The largest gain occurs during periods of higher precipitation and the associated overland flow and increased flow rates.

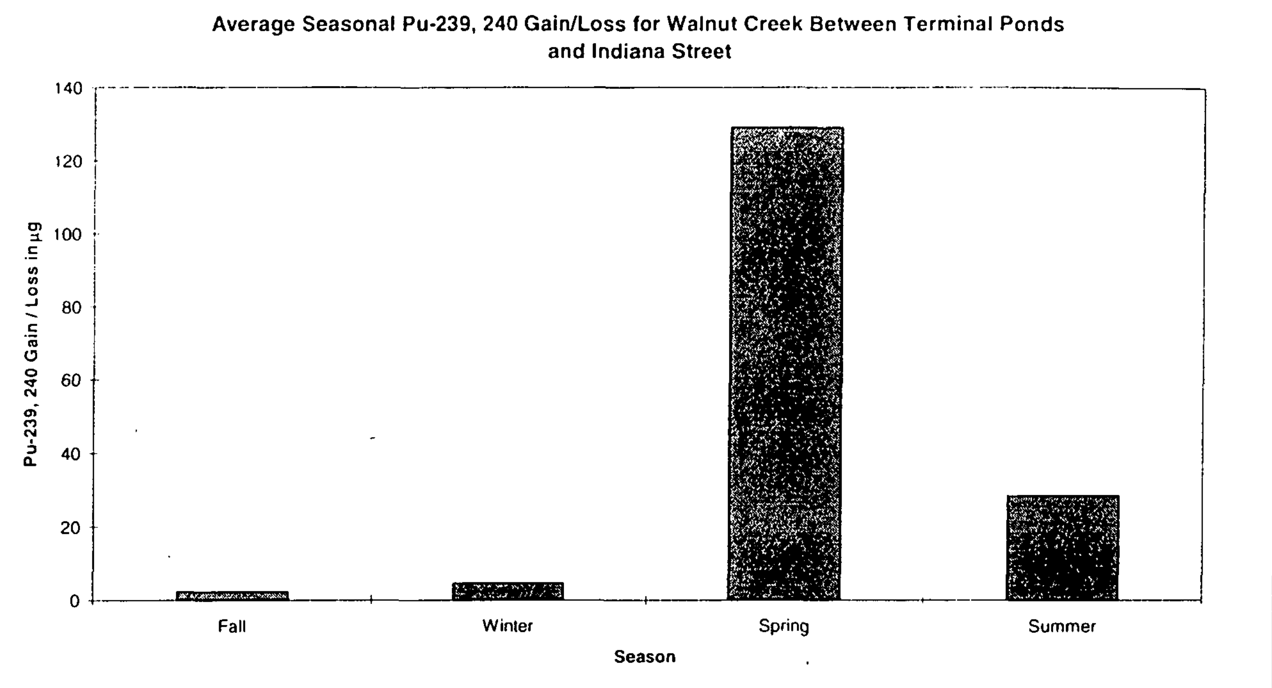


Figure 3-11. Seasonal Gain/Loss of Pu for Walnut Creek.

WY97 Continuous Flow-Paced Monitoring Data

Figure 3-12 shows volume-weighted average monthly activities for continuous flow-paced samples collected in WY97. Analytical results are available through 8/7/97. For all months, the activity increases between the Terminal Ponds and Indiana Street.

Details for each continuous flow-paced composite sample at GS03 is presented in Table 3-2. Elevated samples are indicated in bold. Details for each continuous flow-paced composite sample at GS08 is presented in Table 3-3. Details for each continuous flow-paced composite sample at GS11 is presented in Table 3-4. It is important to note the highly variable activity for the GS03 samples, especially for the three consecutive samples collected during a pond discharge during the period 6/25/97 - 7/6/97 which shows that the activity drops off dramatically for the last sample. This seems to indicate an very intermittent source, a very localized source, or some sort of 'hot particle' mechanism. Regardless, it is apparent that the variability of surface-water activity and the transport mechanisms for Pu are not fully understood.

Table 3-2. Sample Detail for GS03.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
10/14/96 14:38	12/20/96 12:16	69687	0.015	0.42
12/20/96 12:16	12/23/96 11:39	610219	0.003	0.73
12/23/96 11:39	12/26/96 12:13	440743	0.006	1.05
12/26/96 12:13	12/30/96 14:32	124911	0.001	0.05
2/20/97 14:21	2/22/97 15:39	609170	0.017	4.13
2/22/97 15:39	3/3/97 11:08	1101256	0.025	10.98
4/3/97 12:47	4/5/97 16:37	470746	0.022	4.13
4/5/97 16:37	4/8/97 17:12	624135	0.007	1.74
4/8/97 17:12	**4/15/97 11:16**	**709435**	**0.220**	**62.26**
4/15/97 11:16	4/26/97 16:28	1265362	0.018	9.09
4/26/97 16:28	4/28/97 13:57	2054116	0.036	29.50
4/28/97 13:57	5/1/97 16:25	1010904	0.005	2.02
5/1/97 16:25	5/3/97 14:07	1139103	0.016	7.27
5/3/97 14:07	5/6/97 12:04	1479879	0.021	12.40
5/6/97 12:04	5/7/97 13:16	442806	0.013	2.30
5/7/97 13:16	5/9/97 14:50	692467	0.005	1.38
5/9/97 14:50	5/15/97 7:40	1077900	0.027	11.39
5/15/97 7:40	**6/25/97 15:15**	**45743**	**0.465**	**8.48**
6/25/97 15:15	**6/27/97 13:35**	**378015**	**0.165**	**24.88**
6/27/97 13:35	**7/1/97 14:07**	**719360**	**0.184**	**52.80**
7/1/97 14:07	7/6/97 17:14	547709	0.000	0.00
8/5/97 14:24	8/8/97 7:56	724256.5329	0.002	0.58

Elevated samples are indicated in bold.

Table 3-3. Sample Detail for GS08.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
4/28/97 12:02	5/1/97 10:08	718814	0.017	4.87
5/1/97 10:08	5/6/97 14:51	658154	0.006	1.58
5/6/97 14:51	5/12/97 14:33	688436	0.008	2.20

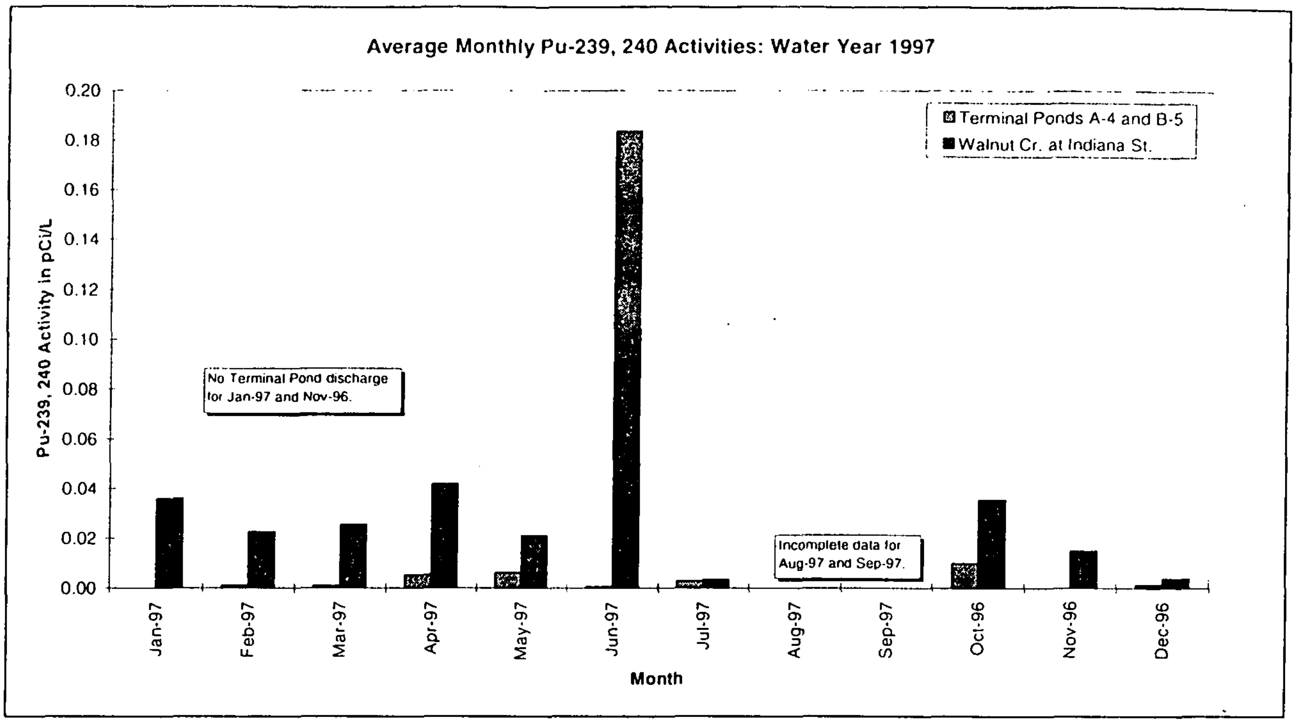


Figure 3-12. Average Monthly Pu Activities in Walnut Creek.

Table 3-4. Sample Detail for GS11.

Sample Start Time	Sample End Time	Discharge Volume During Sample (cubic feet)	Pu-239, 240 Activity (pCi/L)	Pu-239, 240 Load (micrograms)
12/20/96 8:05	12/23/96 8:58	705648	0.001	0.28
12/23/96 8:58	12/26/96 9:07	462124	0.002	0.37
12/26/96 9:07	12/28/96 7:17	105866	0.001	0.04
2/20/97 10:01	2/22/97 13:42	675876	0.003	0.81
2/22/97 13:42	2/25/97 13:52	685803	0.000	0.00
2/25/97 13:52	3/2/97 14:48	395895	0.001	0.16
4/3/97 10:08	4/5/97 16:12	552740	0.004	0.88
4/5/97 16:12	4/8/97 14:31	592151	0.000	0.00
4/8/97 14:31	4/13/97 11:11	665231	0.001	0.27
5/1/97 15:26	5/6/97 13:53	1952671	0.006	4.67
5/6/97 13:53	5/8/97 12:14	514592	0.006	1.23
5/8/97 12:14	5/14/97 11:46	957148	0.006	2.29
6/25/97 13:44	6/27/97 13:15	457604	0.002	0.37
6/27/97 13:15	7/1/97 13:49	758314	0.000	0.00
7/1/97 13:49	7/6/97 8:19	564141	0.003	0.68
8/5/97 11:15	8/7/97 15:14	568103	0.000	0.00

Loads were calculated during Terminal Pond discharges to evaluate changes in loads as the discharge moved through the reach to Indiana Street. Figure 3-13 shows that for all discharges in WY97, loads increased between the Terminal Ponds and Indiana Street, indicative of a source in the drainage.

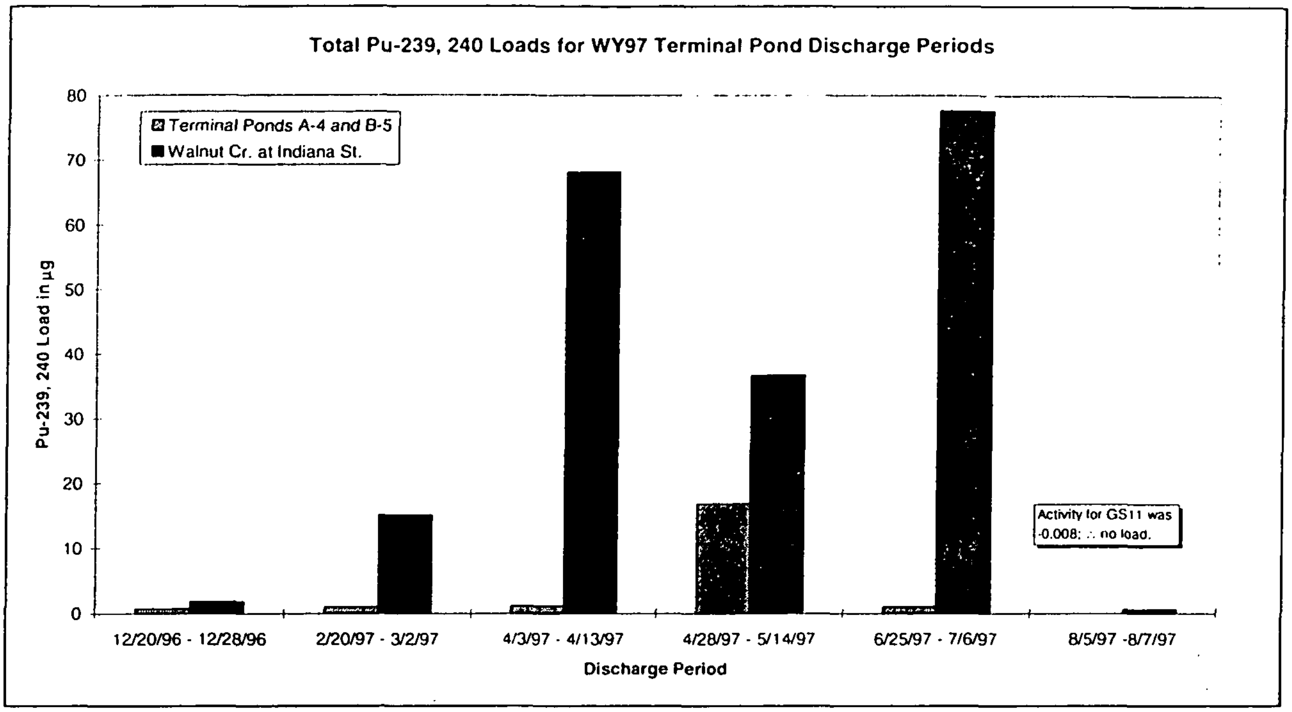


Figure 3-13. Walnut Creek Loads During WY97 Terminal Pond Discharges.

3.2.3. Data Correlations

Flow Rates

As stated previously, is generally agreed that Pu tends to form strong associations with particulate matter (as shown in Figure 3-6). If these particles are transported in surface water, then so is Pu. During high intensity precipitation events, with increased raindrop impact, higher quantities of solids are transported in overland flow. Similarly, higher flow rates in ditches and creeks, generally result in increased TSS values due to higher flow velocity and turbulence. Unfortunately, very few results for TSS at GS03 exist. Therefore correlations using TSS can not be done. Sampling in Walnut Creek conducted since the elevated measurements has included TSS.

Figure 3-14 shows the variation of Pu activity with flow for GS03. The activity plotted is the analytical result for the sample; the flow is the average of the flow rates during each composite grab. Figure 3-14 shows no trends that are indicative of a singular Pu source. An upward trend generally indicates the increased movement of Pu during higher flow rates. This can occur when the source is widespread (movement through overland flow), or when the source exists in the streambed itself (movement through increased scouring). This is the mechanism commonly seen at other Site monitoring locations. A downward trend may indicate that groundwater is the source. For example, during low flow rates a contaminated groundwater source could make up the a larger proportion of the flow, and result in higher activities. During runoff or pond discharges where relatively clean water enters the creek, the groundwater source would be diluted, resulting in lower activities. Figure 3-14 seems to indicate that neither of these mechanisms are present. However, it may also indicate that there are multiple, potentially intermittent, mechanisms and sources.

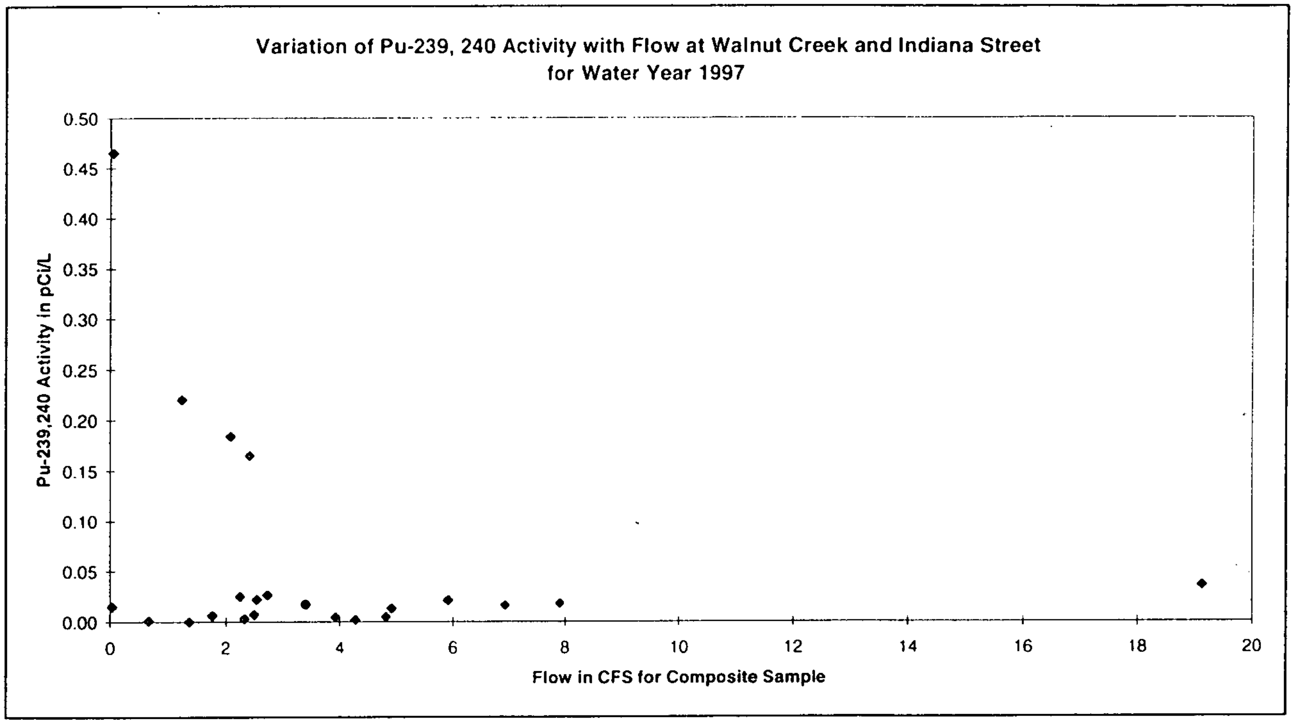


Figure 3-14. Variation of Pu Activity with Flow Rate at GS03.

Precipitation

If it is assumed that a source exists in Walnut Creek below the Terminal Ponds, then increased precipitation (and flow rates) or increased precipitation intensity (raindrop scouring) could result in increased transport at GS03. Figure 3-15 through Figure 3-18 indicate no trends for Pu activities and loads with precipitation. Precipitation data was collected at two gages in the GS03 drainage: RPT3 and GS03. The RPT3 gage is co-located with a telemetry repeater node on the mesa southwest of GS03. The GS03 is adjacent to the sampling location. The total precipitation is the depth for each composite sample period. The precipitation intensity was calculated by dividing the total depth by the number of 15-minute intervals which showed precipitation.

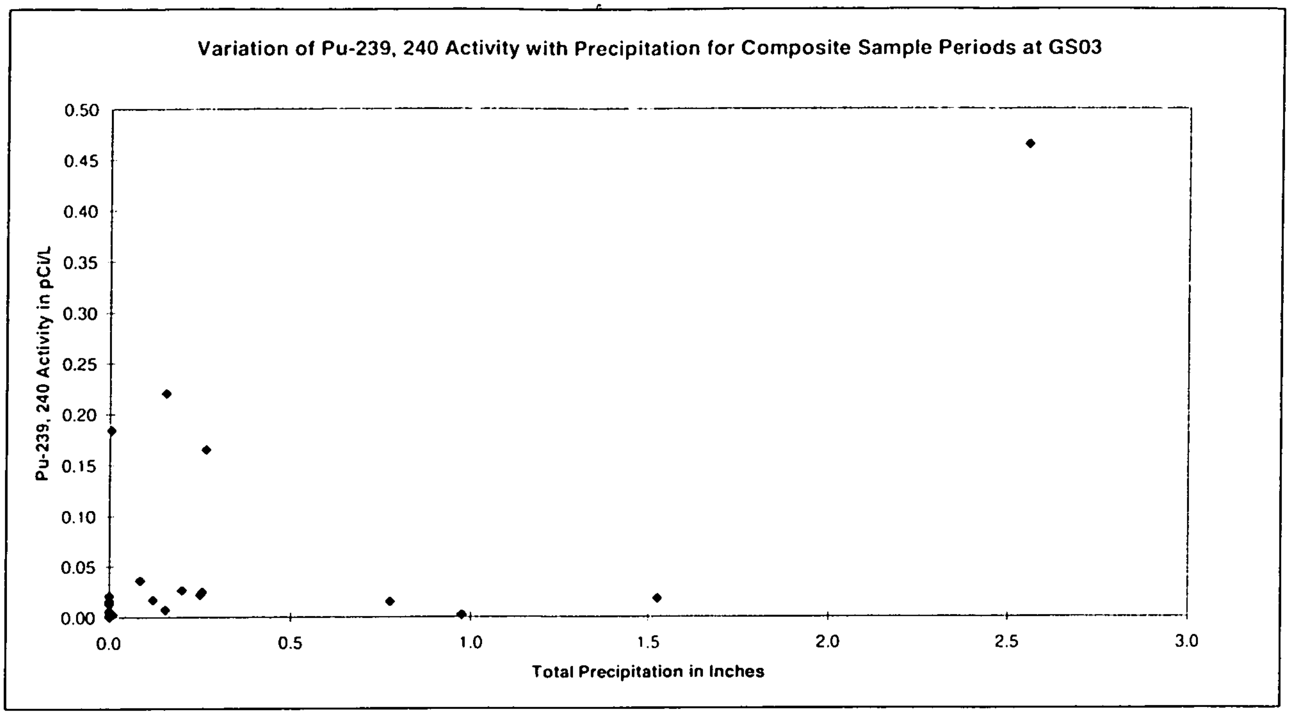


Figure 3-15. Variation of Pu Activity with Precipitation Depth for GS03.

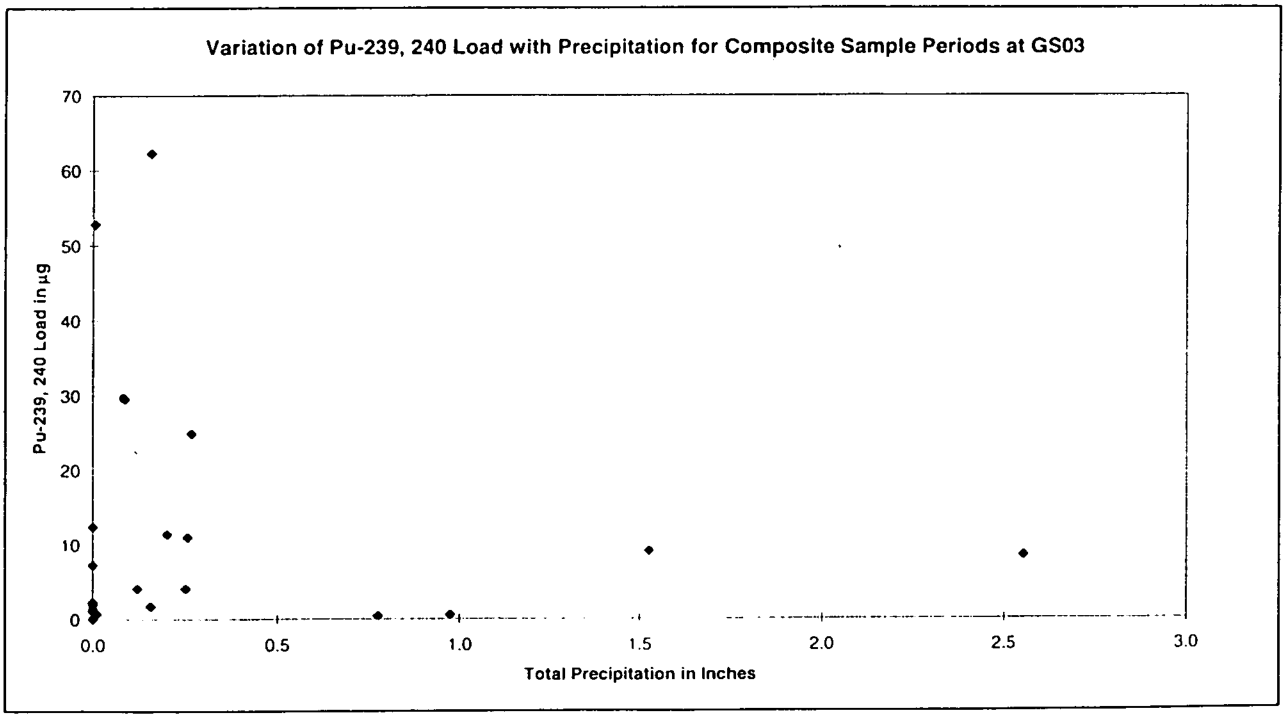


Figure 3-16. Variation of Pu Load with Precipitation Depth for GS03.

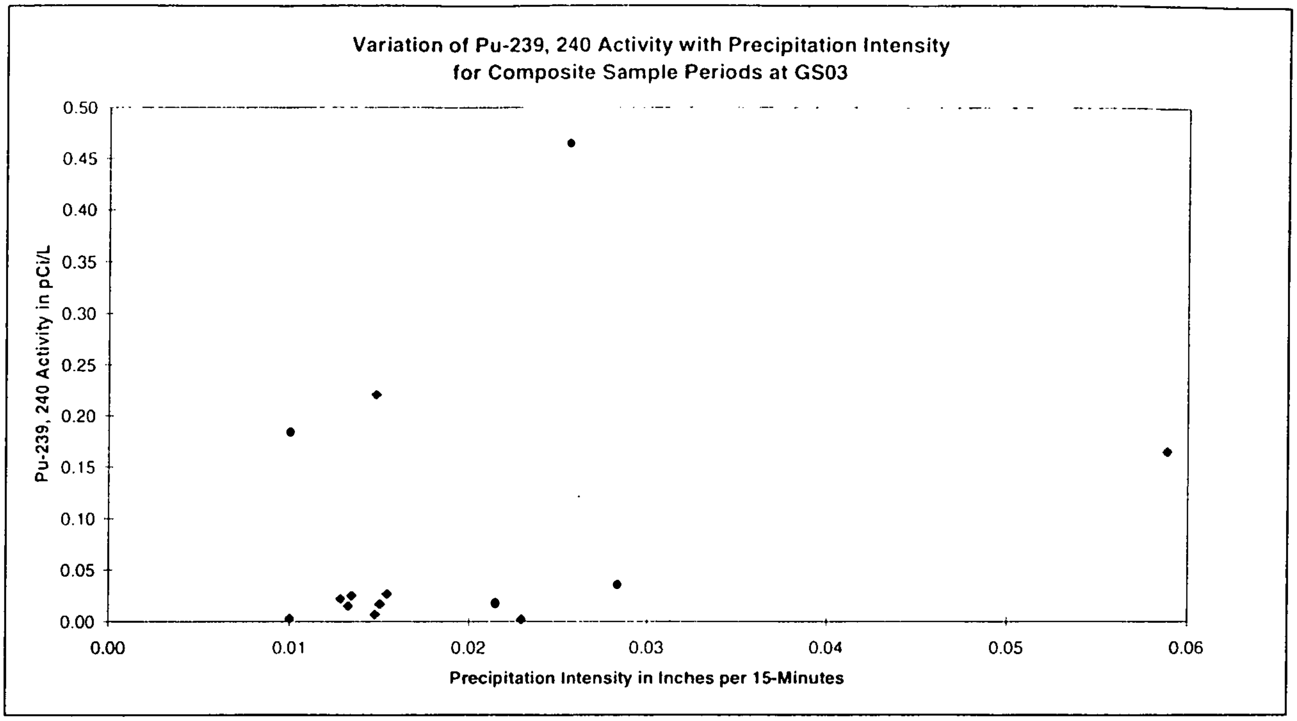


Figure 3-17. Variation of Pu Activity with Precipitation Intensity for GS03.

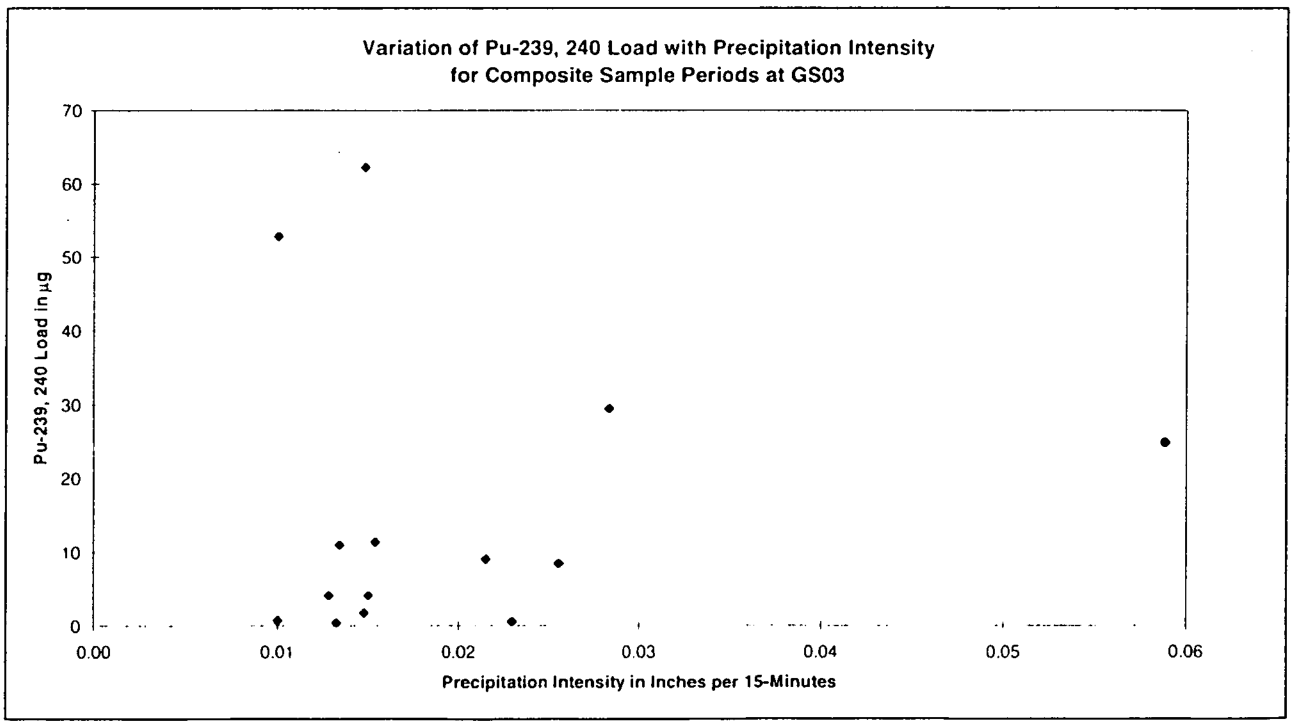
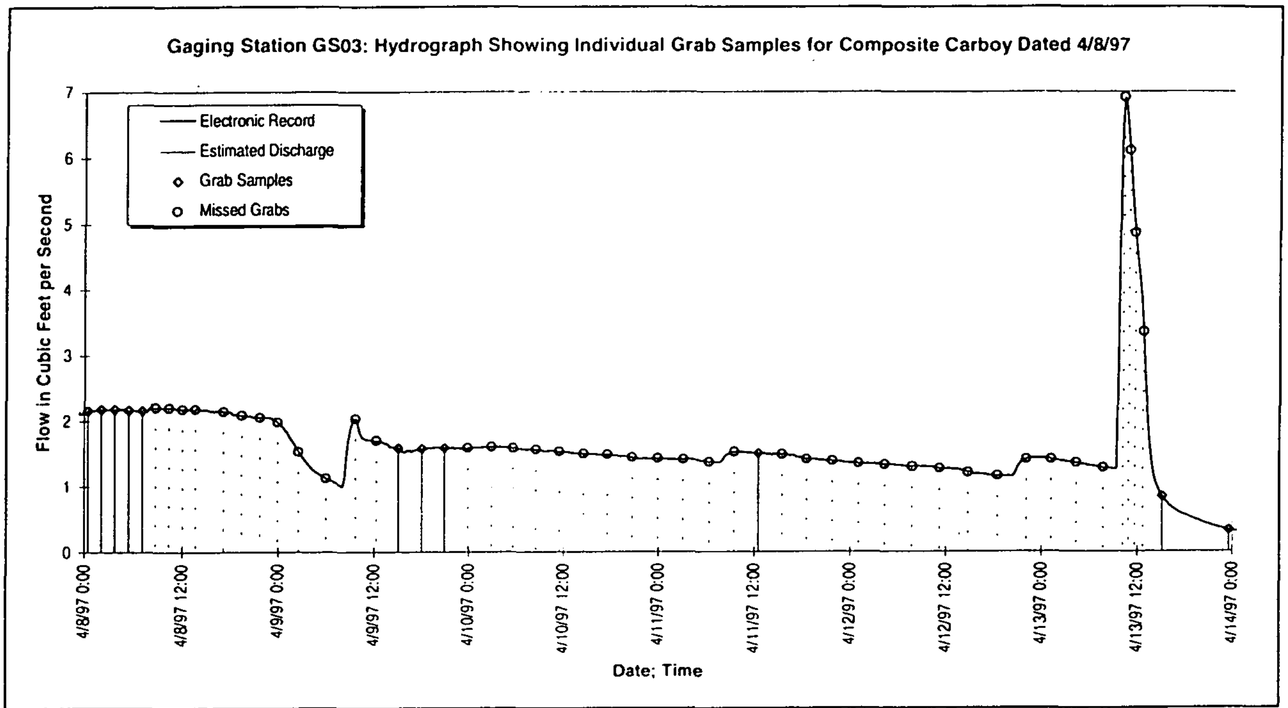


Figure 3-18. Variation of Pu Load with Precipitation Intensity for GS03.

A detailed view of the composite sample periods for the elevated measurements at GS03 is given in Figure 3-19 through Figure 3-24. During A-4 discharges, it can be seen that there for most periods of precipitation, GS03 shows no significant increase in flows, indicating that there was not significant overland runoff which could have transported actinides. However, for the sample dated 6/25/97, an intense precipitation event can be seen to increase runoff at GS03 by ≈ 0.2 cfs (as shown in Figure 3-22). This is indicative of overland runoff in the drainage, and the Pu activity for this sample was 0.165 pCi/L. Additionally, a grab sample during this composite was collected at the peak of this runoff, indicating that water which may contain transported actinide was collected (as shown in Figure 3-21).



Missed grabs were caused by frozen sampling equipment. A low (1 liter) sample volume resulted.

Figure 3-19. Hydrograph and Grab Sample for Composite Sample Dated 4/8/97.

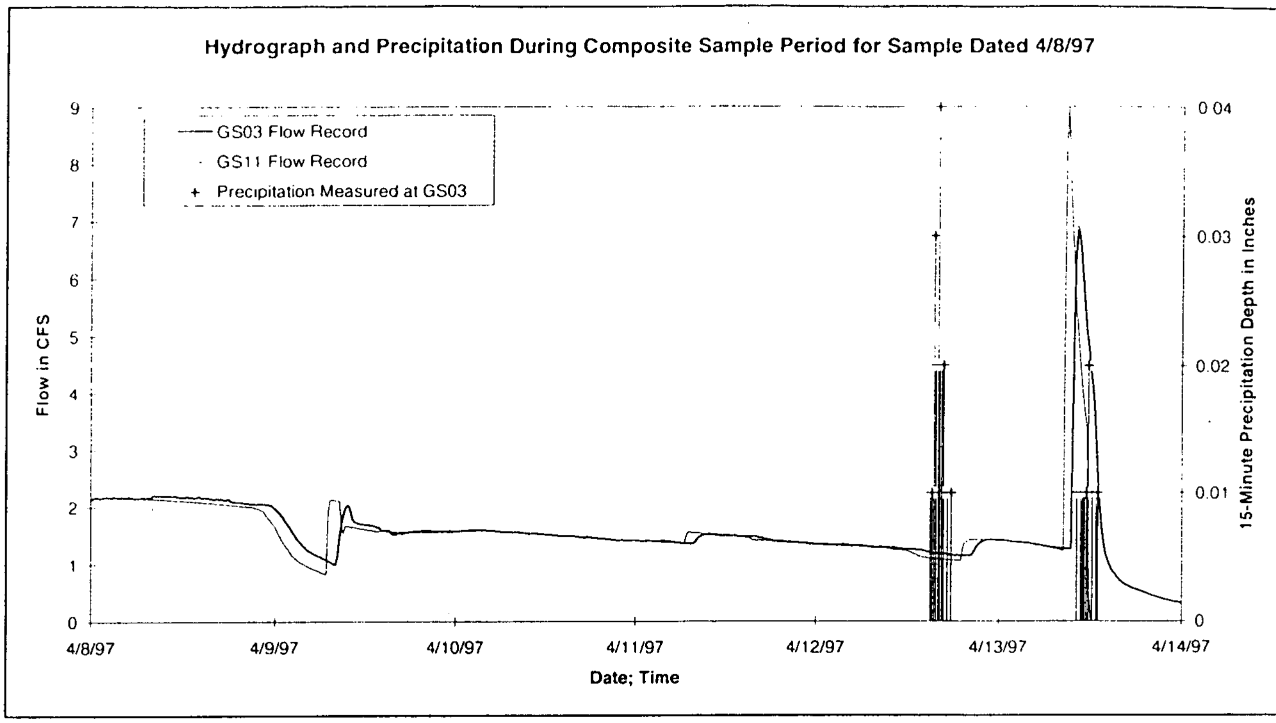


Figure 3-20. Hydrographs and Precipitation for Composite Sample Dated 4/8/97.

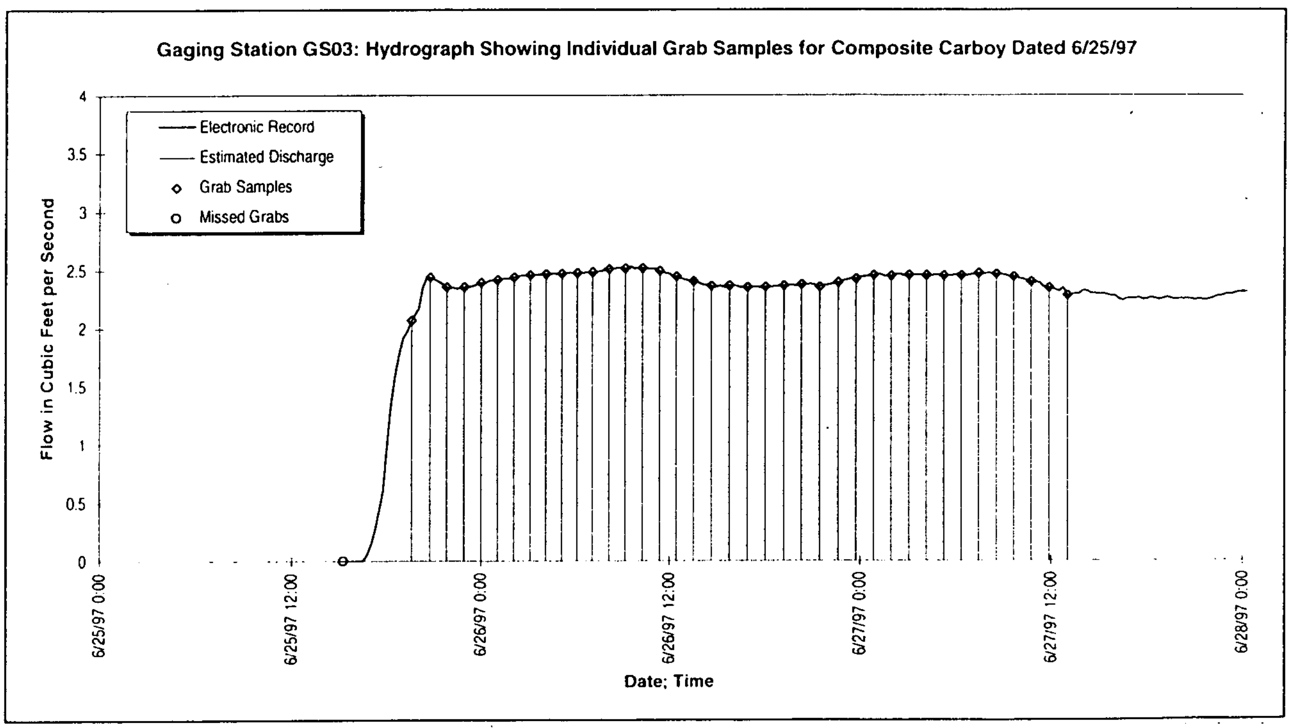


Figure 3-21. Hydrograph and Grab Sample for Composite Sample Dated 6/25/97.

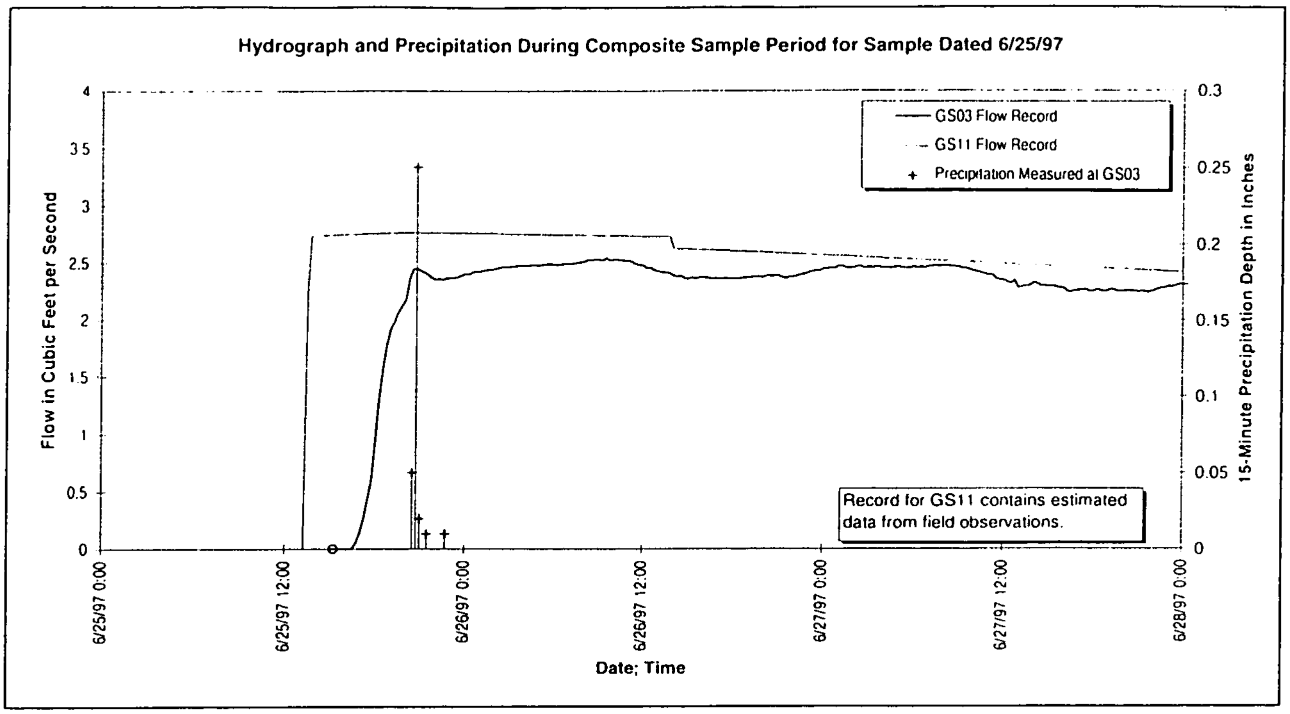


Figure 3-22. Hydrographs and Precipitation for Composite Sample Dated 6/25/97.

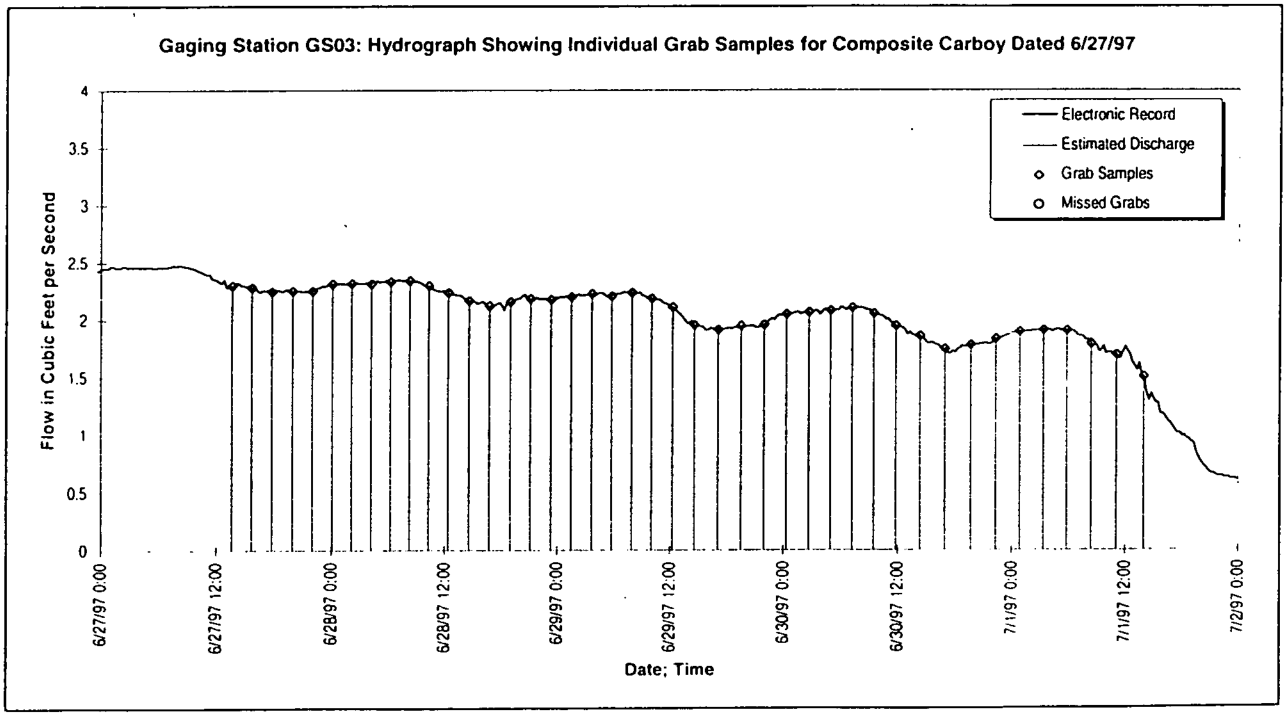


Figure 3-23. Hydrograph and Grab Sample for Composite Sample Dated 6/27/97.

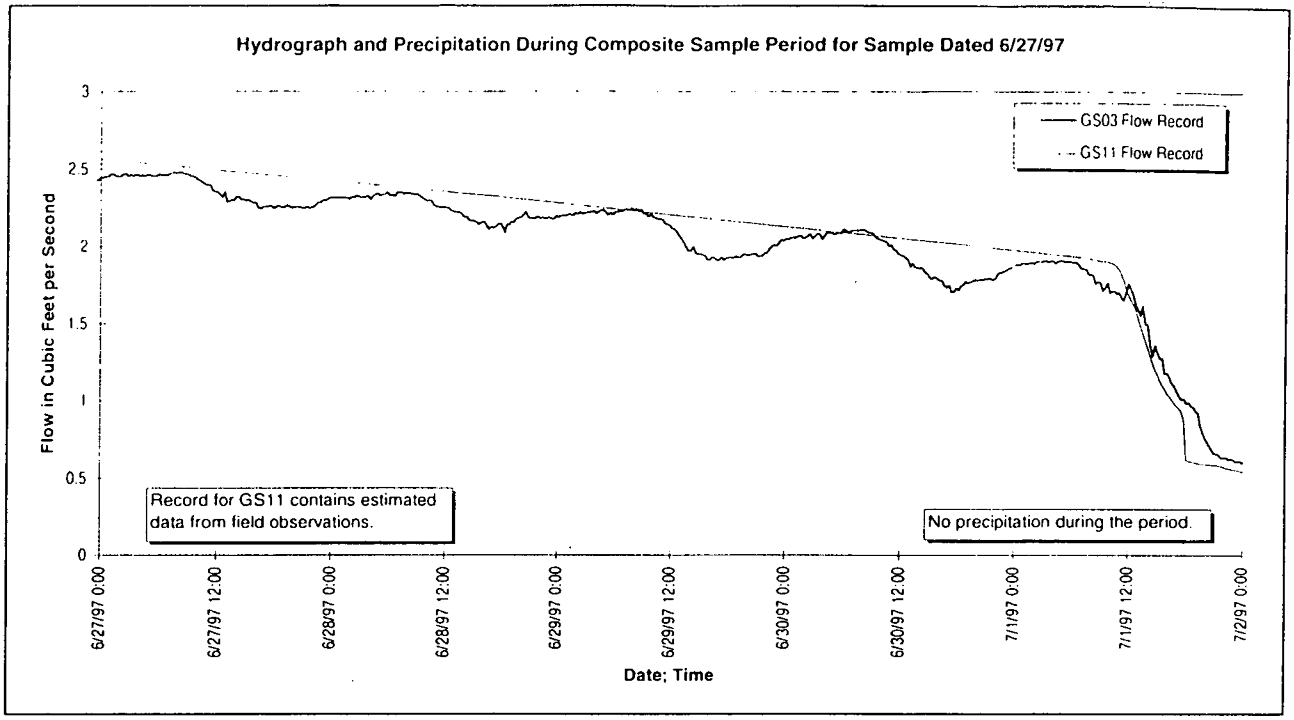
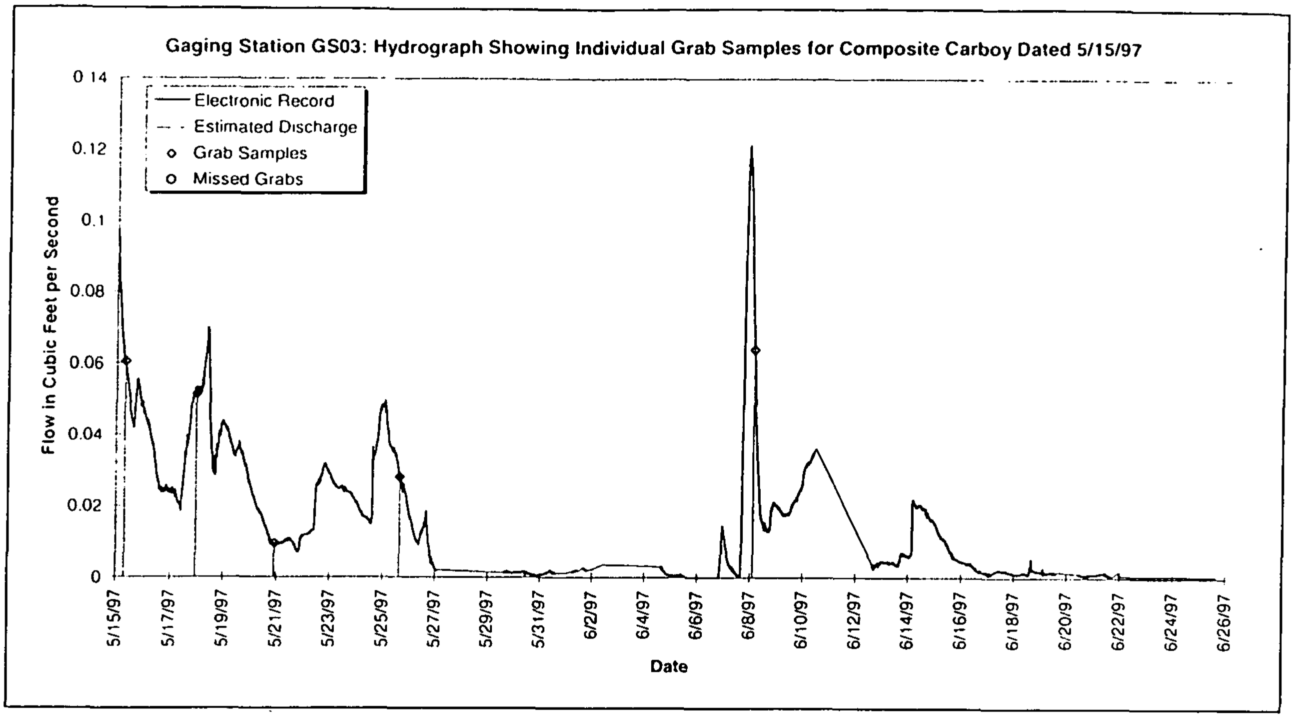


Figure 3-24. Hydrographs and Precipitation for Composite Sample Dated 6/27/97.

For the period during the baseflow carboy dated 5/15/97, approximately 2.5 inches of precipitation fell on the basin. Some of the events show 15-minute totals that are significant. In fact, the runoff response to these events can be clearly seen in Figure 3-26, indicating overland runoff. The flow rates are low compared to the flow rates associated with pond discharges. The Pu activity for this sample was 0.465 pCi/L, and it can be seen in Figure 3-25 that most of the grabs were taken during these runoff periods. This sample was of higher activity that the subsequent samples taken during an A-4 discharge (occurred during 6/25 - 7/6/97; 3 consecutive samples were analyzed; results are 0.165, 0.184, and 0.0 pCi/L respectively). Therefore, a source may have been mobilized due to overland flow, resulting in the elevated 5/15/97 sample. Contaminated sediments may then have been deposited in the streambed, which were remobilized to give the elevated measurements for the first two composites during the discharge. It is then possible that the sediments were flushed from the streambed to give the 0.0 pCi/L result for the final carboy (7/1 - 7/6/97).

The same mechanism may be responsible for the elevated composite sample from 4/8/97 (0.22 pCi/L; Figure 3-19). Three significant precipitation events occurred during 4/2/97 - 4/5/97 (0.68" for the period) which resulted in significant runoff (Figure 3-27). This runoff could have mobilized contaminated sediments through overland flow which may have subsequently been collected in the composite sample from 4/8/97 - 4/14/97. However, the two composite samples collected from 4/3/97 - 4/8/97 show moderate activities (0.022 and 0.007 pCi/L respectively), and if storm runoff could be measured at GS03, then it is reasonable to assume that any mobilized contaminated sediments would also be available for sampling.



The flow rates for the above period are exceptionally low for this time of year. A low (1.2 liter) sample volume resulted due to flow-pacing set to expected flow rates..

Figure 3-25. Hydrograph and Grab Sample for Composite Sample Dated 5/15/97.

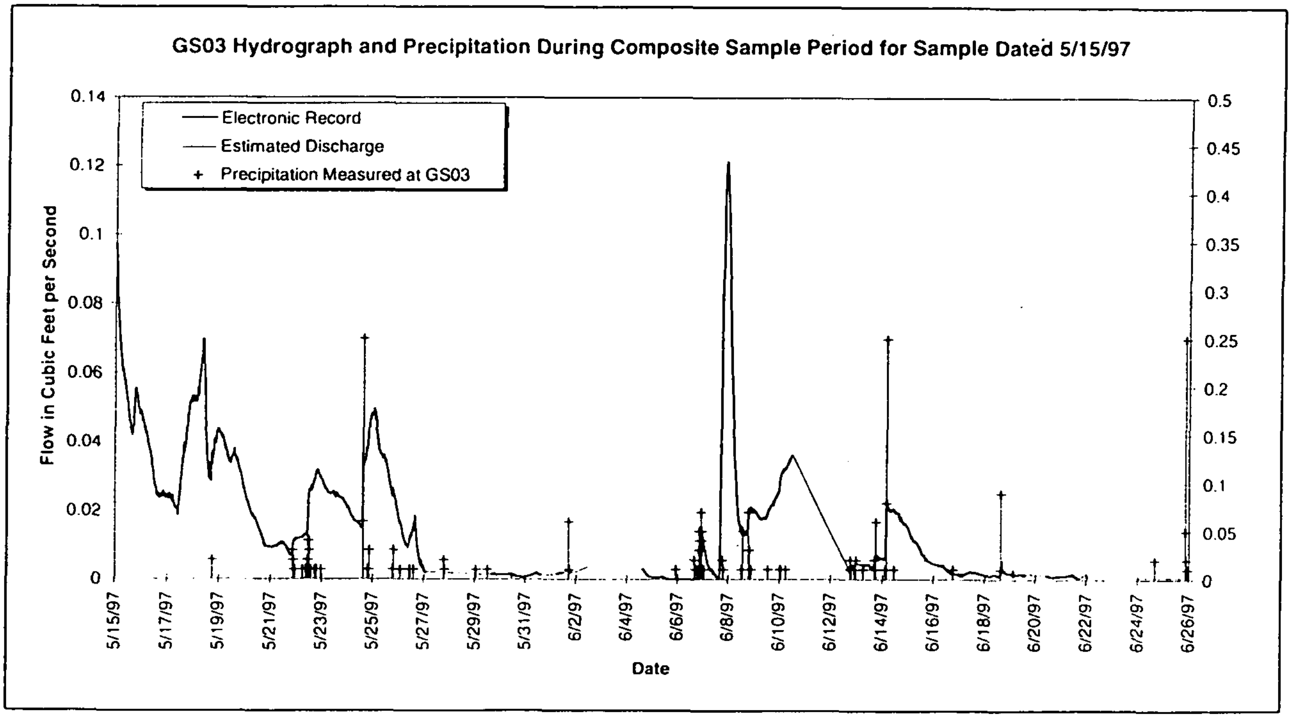


Figure 3-26. Hydrograph and Precipitation for Composite Sample Dated 5/15/97.

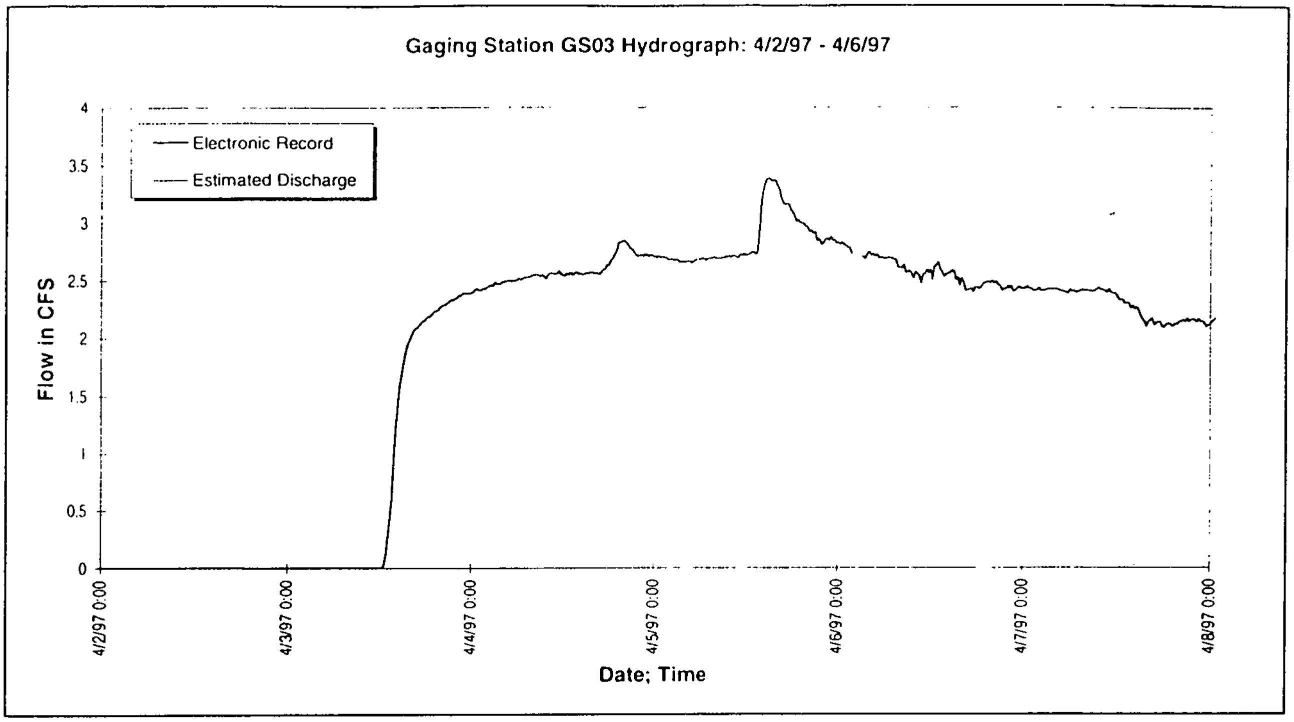


Figure 3-27. GS03 Hydrograph Showing Runoff Peaks Superimposed on A-4 Discharge.

Real-Time Water-Quality Parameters: Specific Conductivity and pH

Average pH and conductivity for each composite sample collection period was calculated. Variation of Pu activity was plotted against the corresponding pH and conductivity. Figure 3-28 and Figure 3-29 do not indicate the existence of significant trends.

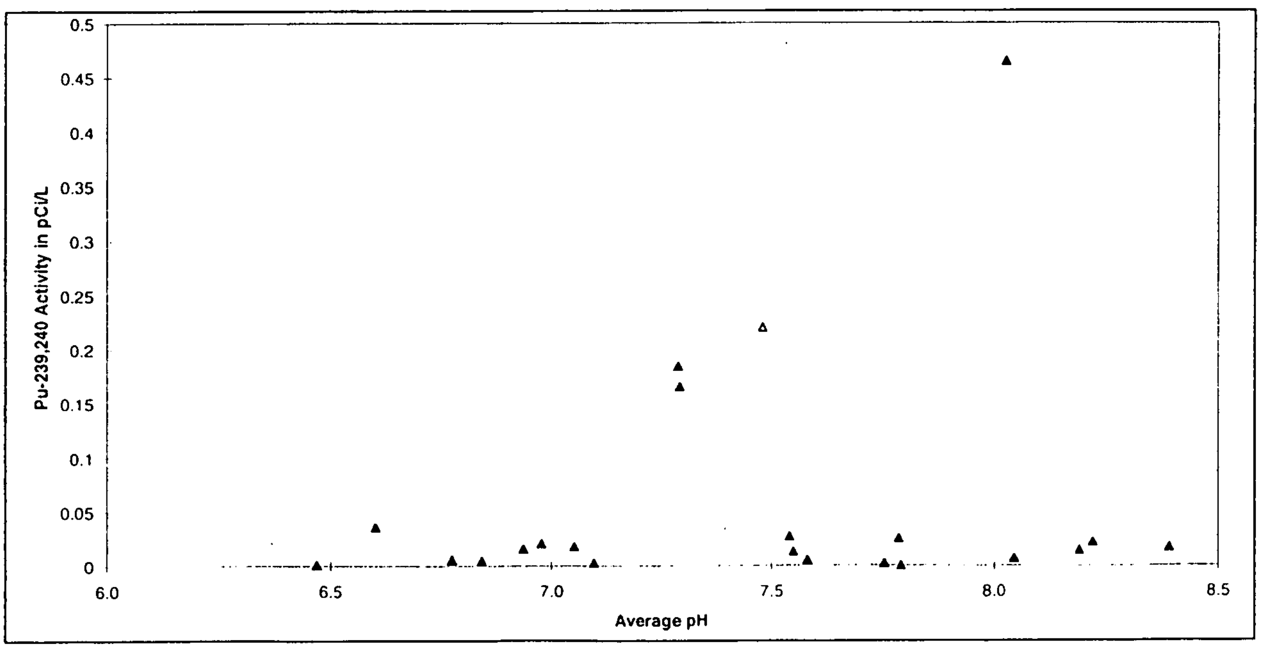


Figure 3-28. Variation of Pu Activity with Average pH for Composite Samples from GS03.

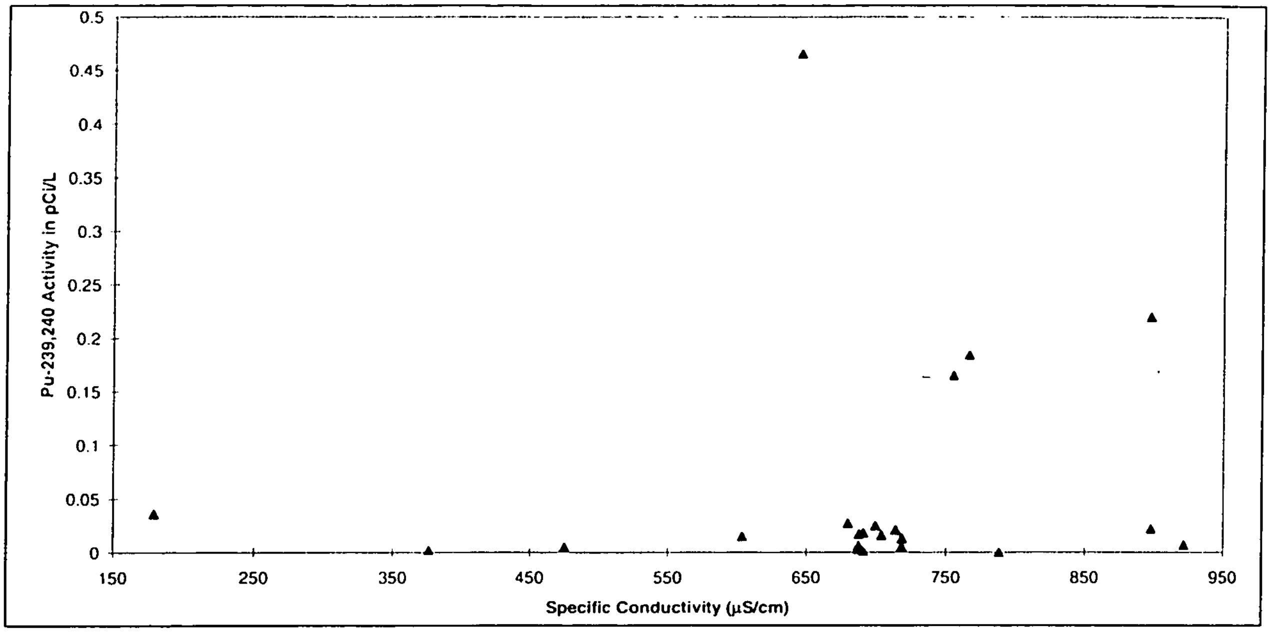


Figure 3-29. Variation of Pu Activity with Average Conductivity for Composite Samples from GS03.

3.3. SITEWIDE SURFACE-WATER DATA

A review of historical reports and analysis of historic data provided the basis for surface-water data investigations. Historical reports consulted include the Background Surface Water and Geochemical Characterization Reports[10] for characterization information for Pu in sediments and surface water within the Walnut Creek drainage basin. These reports, dating from 1989 through 1993, provide details of the studies to examine information about the geochemistry of stream waters, seep/spring water, stream and seep/spring sediments, groundwater, and geologic materials. The characterization studies sought to determine if environmental degradation had resulted from past work practices at the Site. For the study, undistributed (i.e., background) locations were characterized by analyzing environmental materials collected at representative sampling sites. This permitted statistical and geochemical comparisons of background with suspect sample results to identify and assess potential environmental contamination. The Event-Related Surface-Water Monitoring Reports for RFETS[11] summarized the results of the Event-Related Surface-Water Monitoring Program for WY91 through WY93 which utilized the monitoring network to evaluate surface-

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[10] EG&G Rocky Flats, 1993, *Background Geochemical Characterization Report*, September.

[11] EG&G Rocky Flats, 1994, *Event-Related Surface-Water Monitoring Report*, November.

water hydrology and constituent fate and transport at RFETS. The review of Sitewide surface-water data concluded with an examination of radioanalytical data for locations tributary to GS03.

For Progress Report #1, this background review was limited to the Background Geochemical Characterization Report, dated September 1993. This report provided a brief summary of previous reports and presented conclusions about seasonality and surface/groundwater affinities within the Site drainage basins. Surface-water sampling data were statistically summarized for samples collected on a monthly basis during 1989, 1990, 1991, then quarterly in 1992. Chemical data were statistically evaluated for significant differences in quarterly mean concentrations to investigate seasonal components. The report summary noted for stream water that of the 10 radionuclide species analyzed for unfiltered stream water, only 4 showed any significant seasonal differences. One or more quarterly differences were observed for Am-241, gross alpha, Pu-239, 240, and U-233, 234 for a total of 6 significant differences out of 60 possible for all radionuclide species in stream water. However, the overall conclusion of the characterization study is that no systematic seasonal variations are apparent in the mean concentrations of dissolved or total chemicals analyzed for the study of background and surface water from the Site. The study concluded that it is unnecessary to make any corrections in concentrations (or activity) for seasonal variability. The geochemical characterization using Stiff diagrams to plot concentrations of major cations and anions to "fingerprint" waters and identify points of contribution or loss within drainage basins will be included in future progress reports if sufficient data are available to make an interpretation.

For Plan Report #1, the historic monitoring reports (e.g., Event-Related Surface-Water Monitoring) included was limited to the Event-Related Surface Water Monitoring Report for WY93. This report described the characteristics of Site drainage basins and specifics of each of the monitoring locations. Hydrographs for the various monitoring locations were presented, and an analysis of the relative contributions of selected tributaries to the monitoring stations were evaluated. The report provided insight on transport and fate of contaminants.

Numerous conclusions were made in this report concerning both water quantity and quality. Conclusions related to transport and fate of radiochemical parameters are worth mentioning. The variation of radiochemical parameters with metal concentrations and other water-quality parameters provides information on the phase distribution (e.g., dissolved or particulate) of the radionuclides and on factors affecting their transport in the Site streams. Early studies by Harnish[12] found that Pu and Am are primarily found on particulate materials in large particle sizes (0.5 microns), and uranium was primarily found in the dissolved phase. A small fraction of dissolved Pu was found to be complexed by fulvic acids, which are large, naturally occurring , acid-soluble species of humic substances. However, preliminary results of the Actinide Migration Study (discussed in Section 3.9), indicate that, at the 903 Pad and Lip Area, the majority of Pu is

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[12] Harnish, R.A., McKnight, D.M., Ranville, J.F., Stephens, V.C., and Orem, W., "Particulate, Colloidal, and Dissolved-Phase Associations of Plutonium, Americium, and Uranium, in Water Samples from Well 1587, Surface Water SW-51, and Surface Water SW-53 at the Rocky Flats Plant, Colorado", *U.S. Geological Survey Water Resources Investigation Report Number 96-4067, 43 pp.*

associated with the organic fraction. Several graphs were presented to compare the Pu activity with TSS. For GS10 and GS13 data, Pu-239,240 activity appeared to increase with increasing TSS. The TSS/Pu relationship is better defined for sampling locations which receive runoff from smaller drainage areas. The report also examined correlations of Pu activity with other water-quality parameters.

Historic radio-analytical data for this surface water data assessment were derived from the Rocky Flats Environmental Database System (RFEDS). Only monitoring stations tributary to GS03 were included in this investigation (see Figure 3-30 for locations). Data were sorted by analyte type and filtered to limit the analysis to real, target analytical results. The filtered data were used to determine the maximum Pu values for each monitoring location. These values presented in Table 3-5 and Figure 3-31.

Table 3-5. Maximum Total Pu-239,240 Activity for Monitoring Locations Tributary to GS03.

Location	pCi/l
SW003	0.035
SW015	0.006
SW016	0.019
SW025	0.05
SW096	0.494
SW098	0.447
SW099	0.217
SW100	0.047
SW109	0.000
SW111	0.001
SW113	0.009
SW64592	0.001
SW64692	0.004
SW64792	0.002
SW64892	0.001
SW64992	0.007

Anomalous values for Pu sampling within the basin tributary to GS03 were observed at three sampling locations in No Name Gulch. These locations had 1988 samples with total Pu activities above 0.15 pCi/l: SW096 (0.494 pCi/l), SW098 (0.447 pCi/l), and SW099 (0.217 pCi/l). These monitoring locations are adjacent to the toe of the Landfill Pond (see Figure 3-30). These data warrant further investigation of the No Name Gulch tributary system in Progress Report #2.

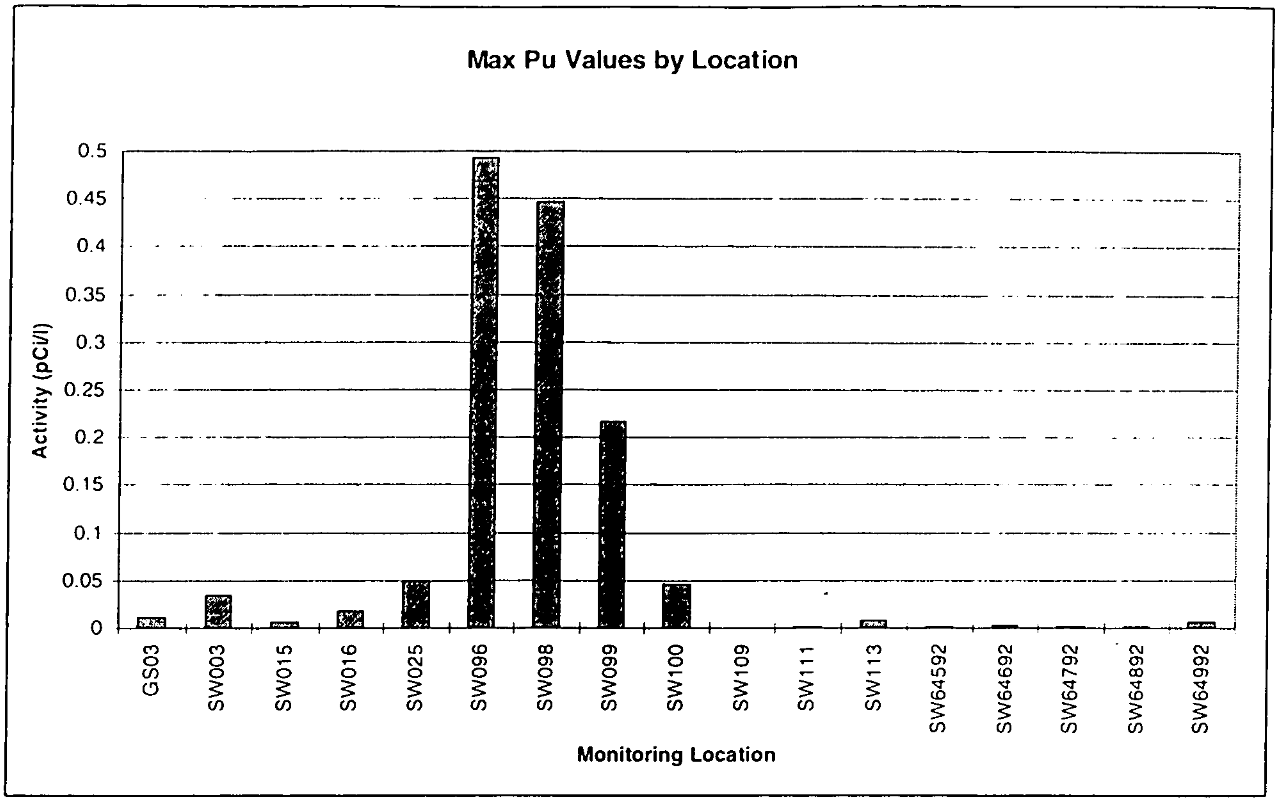

Figure 3-31. Maximum Pu-239,240 Activity for Monitoring Locations Tributary to GS03.

3.4. DATA GENERATED BY RECENT SITE PROJECTS

Site closure activities, including building D&D work, ER projects, excavation work and routine day-to-day operations are ongoing continually at multiple locations around the Site. Activities conducted during FY97 were assessed to determine whether or not they represented a plausible source of the Pu that resulted in the elevated activities observed at Station GS03.

3.4.1. D&D Work

Although D&D operations in former plutonium production buildings was being conducted in the IA drainage basin upstream from GS03 prior to and at the time of the elevated GS03 samples, these types of Site closure activities are not suspected of providing a surface water contaminant source for the following two reasons:

- D&D activities are strictly controlled and monitored for radioactive releases by Radiation Control Technicians (RCTs); and

- D&D activities in the former production facilities were conducted within the buildings (i.e., D&D activities were confined to stripping out and processing equipment and material inside buildings; no major demolition work was performed during this time frame). Each building provides a protective envelope for preventing releases to the environment.

In addition, all of these activities were conducted in the IA. As explained in Section 2.1, surface water flowing from the IA is ultimately routed into and discharged from Pond A-4, which continually had acceptable water quality measured during the time frame of interest. Therefore, D&D activities were determined to not be a likely source of the Pu-239,240 that caused the elevated GS03 activity levels.

3.4.2. ER Projects

The Mound site project, located immediately west of the east inner gate (within the GS03 drainage basin), involved excavating soil contaminated with Volatile Organic Compounds (VOCs), thermally treating the soil onsite, and placing the treated soil back into the excavation hole. It was the one ER project conducted in FY97 that involved significant soil disturbance. Excavation work was initiated on March 21, 1997 and completed on April 8, 1997. Approximately 700 cubic yards of material were removed from the excavation site during this period and stockpiled in the Contaminated Soil Feed Stockpile (CSFS), located immediately west of the east inner gate, for treatment later in the summer. The soil was replaced in September 1997. This project was determined to not be a likely source of the Pu that caused the elevated GS03 activity levels for the following reasons:

- Radiological monitoring was conducted during the excavation and no soil activity levels were monitored that exceeded Tier II action levels (Salomon[13], 1997). Soil activity that was measured above background was associated with uranium-238, not with Pu (Salomon, 1997).

- The Mound Site area was bermed to prevent runoff from contaminating Site surface waters. Incidental waters collected in the excavation or bermed area during the excavation process were sampled and sent to Building 891 for treatment. Sample results did indicate the presence of tetrachloroethane (up to 3.9 ppb), as expected, but gross alpha activities did not indicate the presence of Pu (Barker[14], 1997).

- A radiological "hotspot" detected in the CSFS was removed and drummed on May 9, 1997[15]. The contamination was determined to be caused by prior Trench 3 and 4 remediation activities, and was uranium-238, not Pu.

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[13] Salomon, 1997. Personal communication with Hopi Salomon, RMRS ER Projects staff, September 24, 1997.

[14] Barker, 1997. Personal communication with Sue Barker, RMRS WM&T staff, September 25, 1997.

[15] The drummed material was eventually placed, without the drums, back into the excavation site after it was originally determined to be below Tier II values. Subsequent duplicate analysis of the soil resulted in the Mound site being re-

As explained in Section 2.1, surface water flowing from the IA (which includes the Mound Site) is ultimately routed into and discharged from Pond A-4, which continually had acceptable water quality measured during the time frame of interest. Therefore, the Mound Project was determined to not be a likely source of the Pu that caused the elevated GS03 activity levels.

3.4.3. Excavation Work and Routine Site Operations

Excavation work and routine operations at the Site are subject to the Site Incidental Waters Program. Water collected in utility pits, valve vaults, or excavations is sampled prior to being dispositioned. Such water is pumped to the ground, if the water quality is acceptable, or sent to an onsite treatment facility if sample results indicate the water is not suitable for a release to the environment.

In addition, the drainage basin of Walnut Creek downstream from Pond A-4 and upstream from station GS03 was not impacted by soil intrusive Site activities during the time frame of concern. All excavation work was perfomed upstream from Pond A-4. As described in Section 2.1, Pond A-4 discharges were continually of acceptable water quality throughout FY97. Therefore, excavation work and routine Site operations were determined to not be a likely source of the Pu that caused the elevated GS03 activity levels.

For the reasons outlined above, it is inferred that neither D&D, ER, excavation, nor routine operations caused a release of Pu that resulted in the elevated Pu activities measured at station GS03. Rather, it is implied that the elevated activities are attributed to Pu source(s) created by historic Site operations and natural actinide transport processes.

3.5. GAMMA SPECTROSCOPY INFORMATION

In FY93 and FY94, IA Operable Units (Ous) were surveyed by gamma spectroscopy instrumentation using a High Purity Germanium (HPGe) detector. However, the HPGe study was conducted in areas upstream of the detention pond network and hence will not be discussed here as this report is focused on investigating potential sources located downstream from Terminal Ponds A-4 and B-5.

3.6. SOIL AND SEDIMENT INFORMATION

A review of historical report(s) and analysis of historical data provided the basis for sediment and soil investigations. The reports consulted are the Final Phase I RFI/RI Report Walnut Creek Priority Drainage Operable Unit 6 (OU6), February 1996 and the IA Interim Measure/Interim Remedial Action Surface-Water and Sediment Historical Data Investigation, July 1995.

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excavated and the soil of concern removed and shipped offsite for disposal at NTS. This was completed September 27, 1997.

The purpose of the OU6 Phase RFI/RI is to assess the potential contamination associated with the IHSSs that are located within the Walnut Creek drainage. The OU6 data assessment indicated the presence of potential contaminants in surface soils; subsurface soil; groundwater; pond and stream water; and pond and stream sediments. Potential contaminants identified in one or more of the above listed media include: VOCs, semi-volatile organic compounds, PCBs/pesticides. The primary risk assessment constituents of concern (COCs) were Am and Pu in all media, except groundwater; metals in surface and subsurface soils, pond sediments, and stream/dry sediments; and Aroclor-1254 in pond sediment.

This report provided insight on historic sources of contamination for North and South Walnut Creek. The A-Series Ponds of North Walnut Creek captured and controlled surface-water runoff from the northern part of the IA. Historically, from 1952 to 1979, Pond A-1 was used to hold water discharged from the northern production facilities, including the Building 771 outfall, which contained nitrates and radioactive materials such as Pu and Am. Pond A-2 received direct discharge from Pond A-1 for disposal by natural evaporation. These discharges, although long since discontinued, produced significant amounts of Pu in the stream sediments of North Walnut Creek. Ponds A-3 and A-4 were constructed to replace the A-1 and A-2 from management of stormwater in North Walnut Creek.

The B-Series Ponds of South Walnut Creek began receiving wastes from numerous disposal operations when the plant started operations in 1952. Between 1952 and 1973, decontaminated process water and laundry wastewater were released into South Walnut Creek and subsequently to Ponds B-1 through B-4. Nitrate, Pu, and uranium were contained in these wastes in unknown volumes. Pond reconstruction activities between 1971 and 1973 resulted in disturbances of the bottom sediments of the channel upstream of Pond B-1. This construction caused upstream sediment to be transferred to Pond B-1, increasing the total Pu load. As a result of this activity, it was estimated to have trapped several additional curies of Pu in the sediment within the waste discharge pipe and inlet of Pond B-1.

Historic radio-analytical data for this soil/sediment assessment were obtained from the RFEDS. The data query was limited to monitoring stations tributary to GS03, including the region around the Landfill and Landfill Pond (see Figure 3-32). Data were sorted by analyte type and filtered to limit the analysis to real, target analytical results. The filtered data were used to determine the maximum Pu values for each soil/sediment sampling location. These values presented in Figure 3-33.

A review of the soil/sediment maximum values indicate higher Pu in soils for the southern tributaries to the Walnut Creek drainage basin. Soil and sediment Pu activities as high as 0.220 pCi/g are noted from a location at the toe of Dam A-4. Soil/sediment sampling data also show higher values in the vicinity of the Landfall and Landfill Pond. The maximum soil and sediment activity observed in the area of investigation is 6.995 pCi/g just north of the East Access Road; however, this location is not tributary to GS03. These data will be further examined in Progress Report #2 when analytical results from recent sediment sampling in Walnut Creek (Figure 3-1) are available.

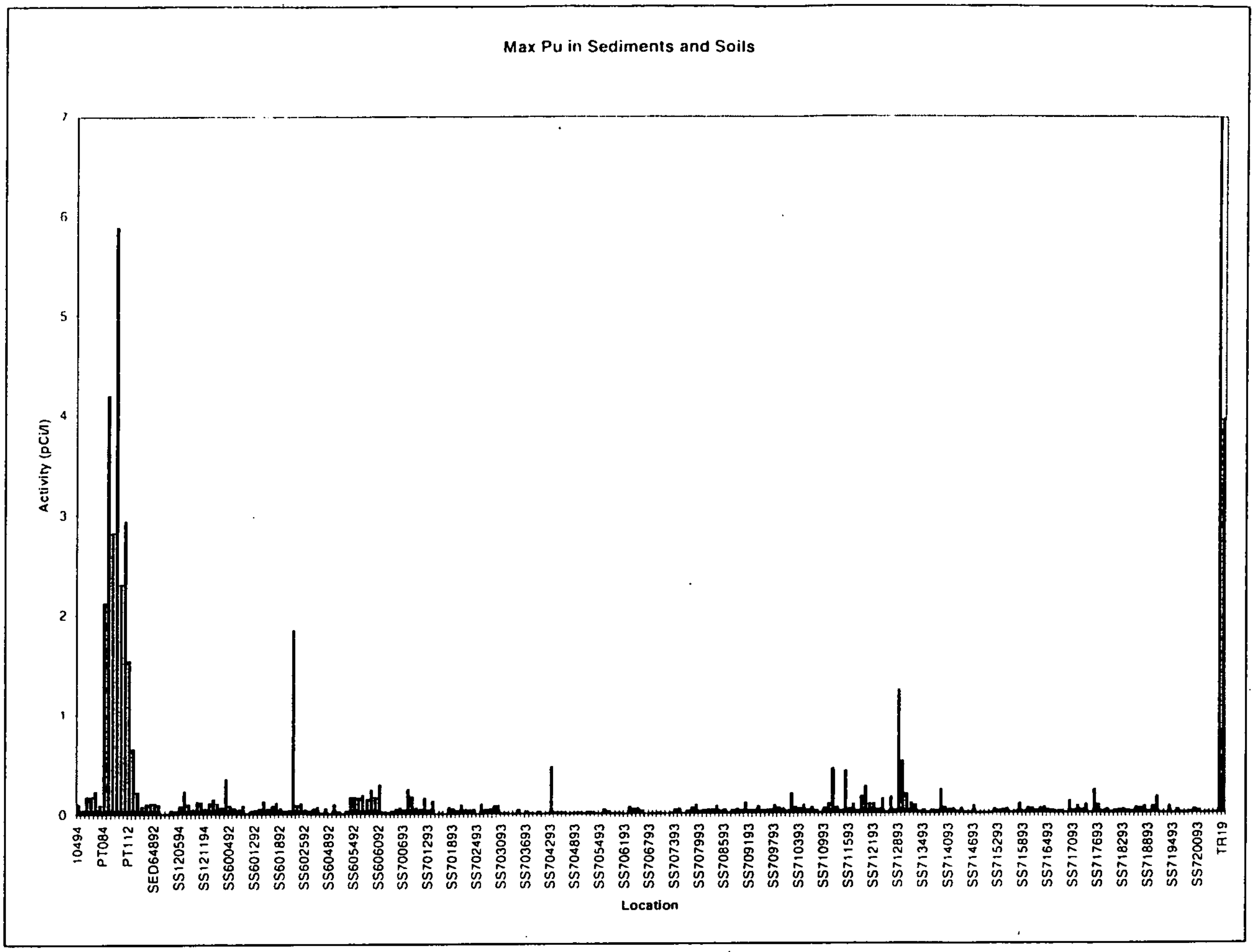

Figure 3-33. Maximum Pu Values in Soil/Sediment for Locations Tributary to GS03.

3.7. HISTORICAL RELEASE REPORT[16] INFORMATION

A small flume pond is located on the Walnut Creek drainage immediately west of and upstream from Indiana Street. It has also been referred to as Flume Pond, Walnut and Indiana Pond, and Walnut Creek Gaging Station. GS03 is situated on the east side of the pond at the point of discharge. The pond was constructed in October 1978, and is used to measure Walnut Creek flow. Aerial photographs of the Walnut Creek drainage show a small pond at the Walnut Creek and Indiana location prior to 1978. This was most likely due to vegetation and sediment blocking the channel flowing under Indiana Street, causing the water to accumulate in the ditch to the west. At one point, the channel was cleared of debris and the pond

[16] U.S. Department of Energy, 1992, *Historical Release Report for the Rocky Flats Plant*, Rocky Flats Environmental Technology Site, Golden, CO, June.

shrunk.[17,18] This is consistent with the aerial photographs, which show the pond decreasing in size from the late 1960's to the mid 1970's. A pump station existed prior to construction of the gaging station, and monitoring samples were taken at that location.[17,18] Some literature refers to Baseline Reservoir[19], at the point where Walnut Creek crosses under Indiana Street, but no other documentation was found that linked this designation to the RFETS.

The GS03 flume pond was identified as an IHSS in the Interagency Agreement of 1991, and the constituents potentially present there are the same constituents potentially released to North Walnut Creek or South Walnut Creek (A-Series and B-Series drainages). Past radioactive releases to the A-Series drainage included routine discharges of laundry wastewater from B771, with low levels of radioactivity, from approximately 1953 until 1957. Periodic releases were made until 1965. Past radioactive releases to the B-Series Drainage included decontaminated process wastewater, WWTP effluent, and laundry wastewater. Sanitary effluent from the WWTP has been discharged from plant inception to present. The only known radioactive effluent entering the WWTP and the B-series ponds occurred between 1969 and 1972 when low level laundry effluent was channeled through the treatment plant. Untreated process waste, primarily decontamination wastewater, from Building 774, was discharged to Pond B-2 from at least July 1953 until January 1954. Other buildings that discharged decontamination laundry wastewater to the B-series Ponds included Building 771, from at least July 1953 until 1965, and B778, from December 1973 until 1980.

Radioactive releases to the A-series and B-series drainages resulted in accumulation of significant levels of Pu in the sediments of Pond A-1, the B-series Ponds, and North Walnut Creek. From 1971 to 1973, the ponds underwent major reconstruction. During this time period, a study[19] was done which showed that reconstruction activities resulted in increased Pu concentrations in the surface water samples from Pond A-1, but not in the pond sediment. The study suggests that resuspension of the Pu allowed it to migrate downstream towards Great Western Reservoir. In contrast, the B-series Ponds showed that reconstruction activities had a marked effect on mean sediment concentrations. A sediment study conducted by Colorado State University showed that Pu activity in Pond B-1 sediment in June 1973 varied from 10 to 502 pCi/L of dry sediment.[20] In addition, Pond B-3, the first pond to undergo reconstruction, showed a marked decrease in sediment activity after peaking in late June 1972. This can be attributed to the deposition of sediment in the pond during and after the pond remodeling, that contained lower concentrations of Pu. Pu

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[17] Personal Communication, Daryl D. Hornbacher, Retired RFP Employee, September 18,1997.

[18] Personal Communication, Ralph Hawes, Retired RFP Employee, September 18, 1997.

[19] Paine, D., 1974, "Plutonium in Rocky Flats Freshwater Systems" in *Transuranic Elements in the Environment*, pp. 644-658.

[20] Johnson, J.E., S. Svalberg, and D. Paine, 1974, "Study of Plutonium in Aquatic Systems of the Rocky Flats Environs", *Final Technical Report, Dept. Of Biology and Radiation Biology and the Dept. Of Animal Sciences*, Colorado State University.

concentrations in Pond B-2 peaked in July 1972, and those in Ponds B-1 and B-4 peaked in August. This suggests that pond reconstruction may have played a major role in the redistribution of Pu since this is the order in which remodeling occurred. Pu concentrations also increased in the sediment sampled at Walnut Creek and Indiana Street, which indicated that activity may have escaped the holding pond system during the period of reconstruction.

Another activity that may have introduced a potential source of contamination in the Walnut Creek drainages occurred in the early 1980's. Actions were taken at Pond B-5 to reduce the potential for offsite movement of contaminated sediments. This required a modification of the discharge structure for this pond, at which time some sediments present in the pond were removed from the drainage and deposited in the Soil Dump Area in the northeast buffer zone. The Soil Dump Area, which is located between the A-series and B-series drainages immediately north of Pond B-1, was used for the dumping of soil beginning in 1968. The possible sources of the soil dumped in this area include soil excavated for a multiple building construction project in the late 1960's, and sediments removed from the Pond B-5 discharge outlet modification activities. No documentation was found that contained analyses of the soil from either project, and it is not known whether this soil was further disposed of.

Information regarding maintenance activities at the flume pond is limited. In May, 1979 following construction, minor erosion at the Walnut Creek Gaging Station necessitated repair and reseeding, which was completed in August, 1979. Beginning in November, 1980, the pond was cleaned out on occasion to reduce buildup of sediments on the bottom or to reconstruct the flumes. The sediments were placed on the south side of Walnut Creek upstream of the pond. A primary source of these sediments in the pond was the McKay Ditch Bypass, which was originally constructed as an unlined ditch, and therefore carried considerable amounts of entrained sediments. It is not known how long the practice of cleaning out the pond was carried out.

It is evident that the stream and pond sediments in the Walnut Creek drainages have been contaminated in the past, due to numerous radioactive releases discharged to the ponds, and from disturbance of the sediments during construction activities. Although recent remediation projects in the area have been minimal, it is reasonable to expect that this contamination may be encountered again given the right conditions.

3.8. GROUNDWATER DATA

3.8.1. Groundwater Monitoring near GS03

Groundwater in the vicinity of RFCA POC GS03 consists of a shallow, alluvial aquifer flowing from west to east across the Site. There is no known direct hydraulic connection between this shallow alluvial aquifer and deeper aquifers in the Denver Basin which are used for domestic water systems[21]. In the spring and early summer, this shallow alluvial aquifer of the Rocky Flats Alluvium and Arapahoe Formations is recharged by precipitation and lateral groundwater flow. In the late summer and early fall, these formations are recharged primarily by groundwater lateral flow[21]. In the Walnut Creek stream drainages, groundwater discharges as seeps which typically occur at the base of the Rocky Flats Alluvium where individual sandstone lenses become exposed to the surface[21].

The shallow groundwater below GS03 is currently monitored in Well 41691, located between GS03 and the eastern Site boundary (Figure 3-34). Surrounding Wells, 10894, 11894, and 11994 (Figure 3-34) were also sampled briefly following their installation in FY94 in response to high Pu-239, 240 and Am-241 values observed in Well 41691. Samples for analysis of Pu-239,240 and Am-241 are currently collected semi-annually from Well 41691. Prior to May 15, 1996, samples from Well 41691 were collected at least quarterly. Between December, 1994 and October, 1996, Wells 10894, 11894, and 11994 were sampled 1, 6, and 8 times respectively for radionuclide analysis. All groundwater samples discussed in this document were collected using bailers.

3.8.2. Summary of Groundwater Data[22]

Total radionuclide and TSS concentrations from samples collected from Well 41691 following installation in 1991 are presented in Figure 3-35 and Figure 3-36, respectively.

Concentrations of Pu, Am, and TSS show decreasing trends with time in samples retrieved from Well 41691, with high values in 1993 and early 1994. In response to these high Pu-239,240 (maximum recorded value = 1.1 pCi/L) and Am-241 (maximum value = 3.2 pCi/L) values, three additional monitoring wells were installed to sample the shallow groundwater near the eastern Site boundary near Walnut Creek. Pu-239,240 and Am-241 data collected from these wells are presented in Figure 3-37 and Figure 3-38.

Noting the difference in scale for Figure 3-37 and Figure 3-38 as compared to Figure 3-35 and Figure 3-36, it is apparent that Wells 10894, 11894, and 11994 did not verify the occurrence of continuing contaminant transport via groundwater upgradient or downgradient of Well 41691.

Similar to Pu and Am data from Wells 10894, 11894, and 11994, the TSS data show no apparent trends with time. The TSS results are summarized in Table 3-6.

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[21] 1994 *Rocky Flats Environmental Technology Site Environmental Report*, Kaiser-Hill Company, L.L.C., Golden, CO 80402.

[22] Data are summarized statistically based on a normal distribution.

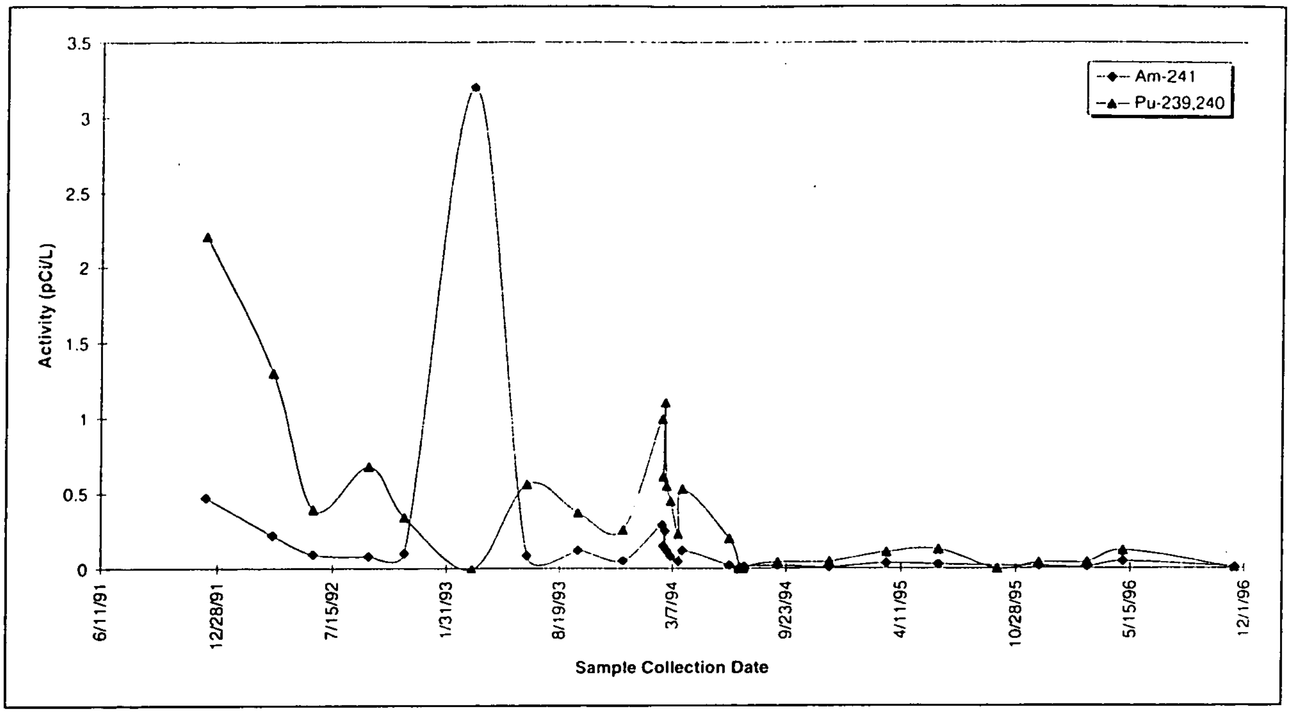


Figure 3-35. Pu-239,240 and Am-241 in Groundwater Samples from Well 41691.

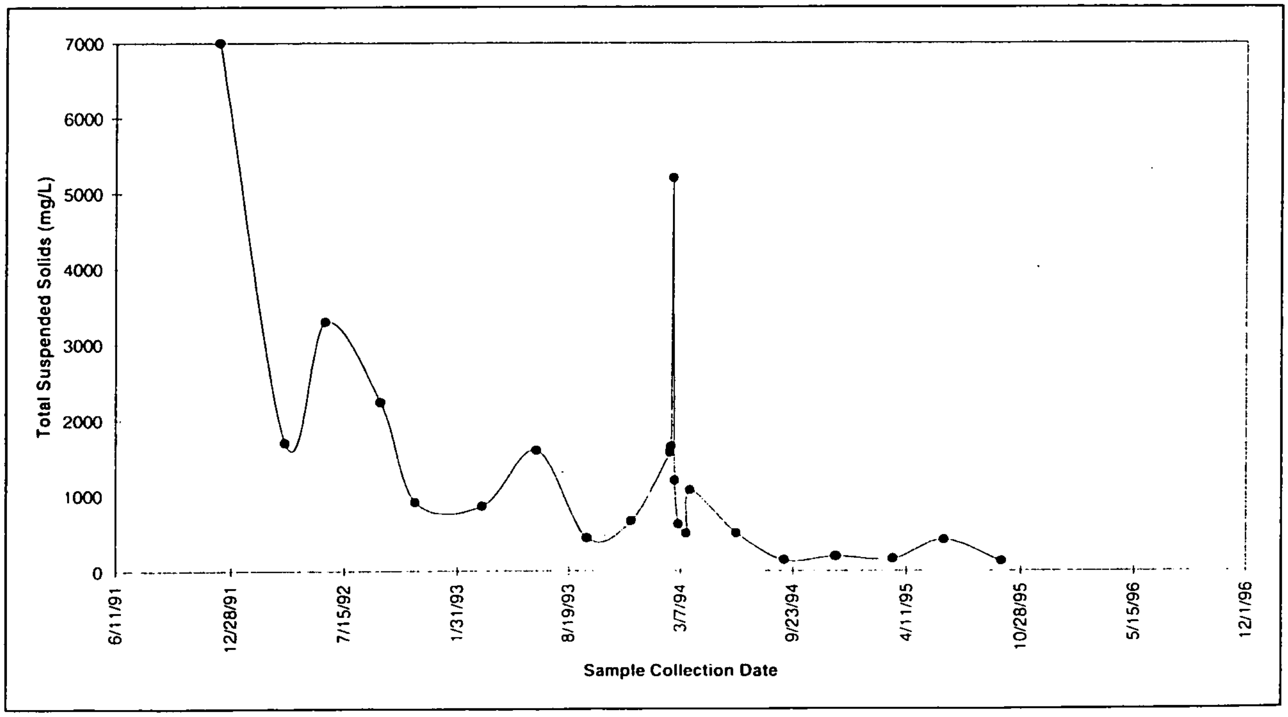


Figure 3-36. Total Suspended Solids in Groundwater Samples from Well 41691.

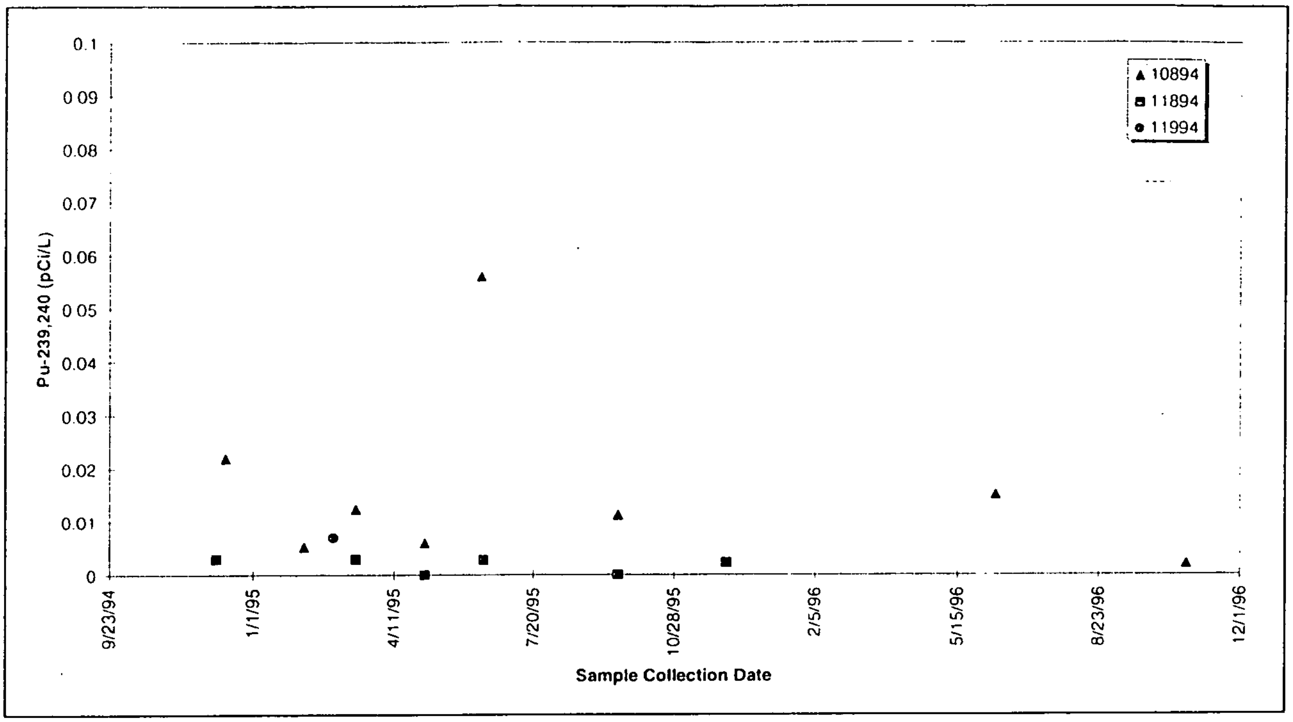


Figure 3-37. Pu-239,240 in Groundwater Samples form Wells 10894, 11894, and 11994.

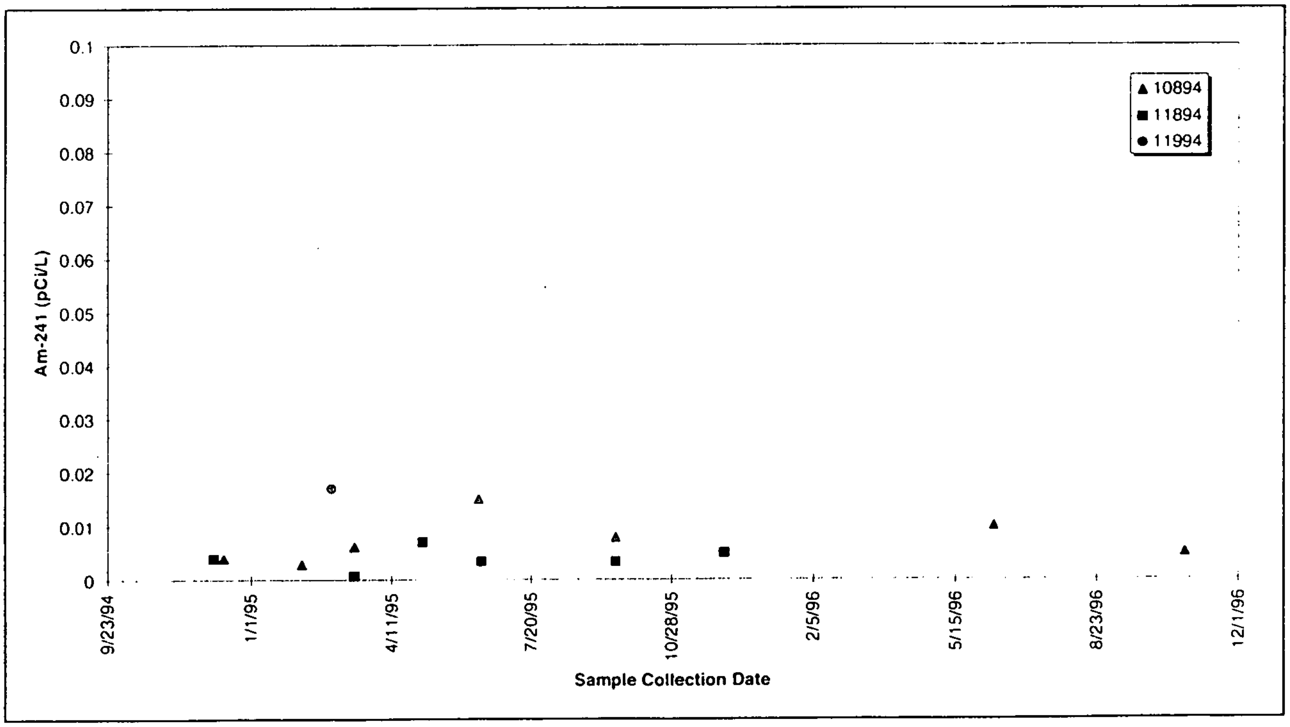


Figure 3-38. Am-241 in Groundwater Samples from Wells 10894, 11894, and 11994.

Table 3-6. Summary of TSS Data for Wells 10894, 11894, and 11994.

Well Number	Average TSS (mg/L)	Standard Deviation	Number of Samples
10894	285	286	6
11894	32.7	23.7	5
11994	2.90	2.69	2

Though few TSS measurements were taken and results show significant variance relative to the magnitude of the means, TSS values in the wells constructed in FY94 are significantly lower than those recorded from samples from Well 41691, particularly in samples with correspondingly high Pu and Am concentrations.

The depth to the groundwater from the ground surface is measured monthly in all actively sampled wells. Data from Well 41691 is presented graphically in Figure 3-39, and data from all 4 wells are statistically summarized in Table 3-7.

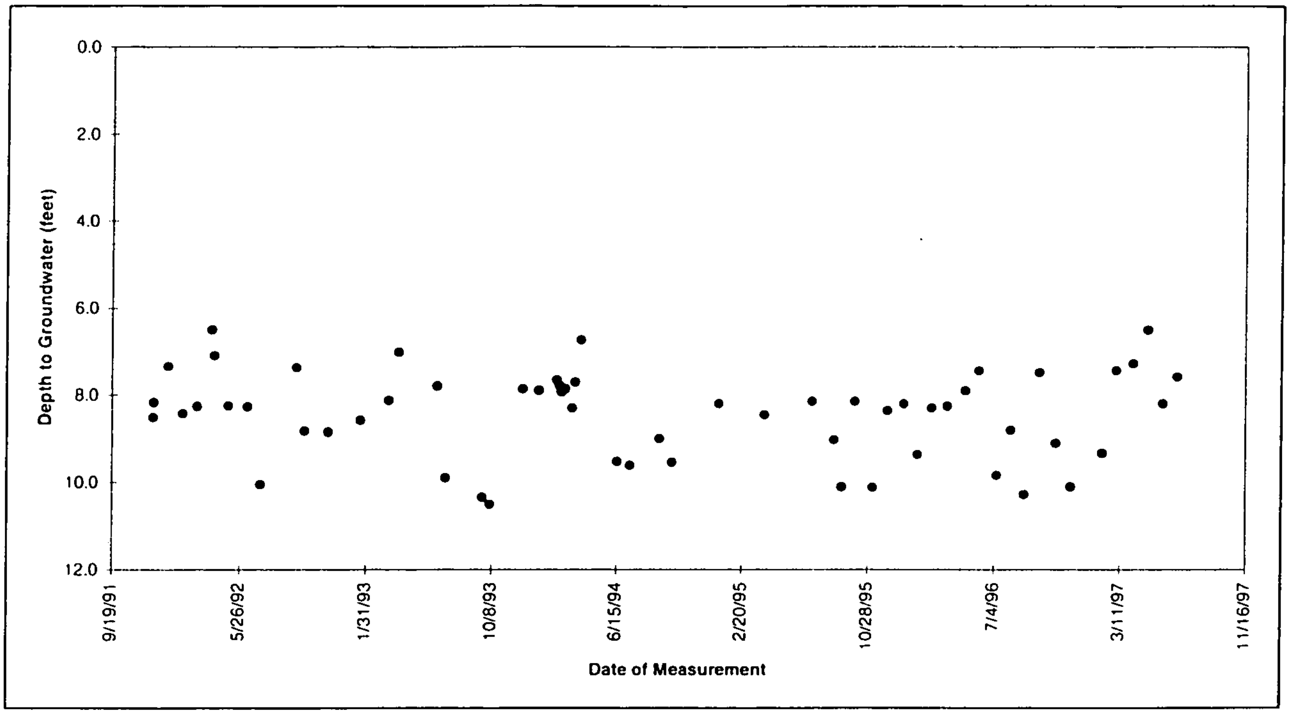


Figure 3-39. Depth to Groundwater in Well 41691.

From this data, it can be seen that groundwater levels fluctuate by 3 to 4 feet annually in Well 41691. With a ground surface elevation of 5644 feet above sea level, seasonal discharge to the flume pond above GS03 is possible. The pond is fairly shallow, though the actual depth is uncertain, with a mean surface elevation of approximately 5644 ft. In fact, WM&T personnel observed water flowing out of the pond on August 21, 1997 with no simultaneous surface-water inflow via Walnut Creek. In short, groundwater is likely to discharge seasonally into the small pond above GS03.

Table 3-7. Summary of Groundwater Level Measurements for Wells 41691, 10894, 11894, and 11994.

Well Number	Average Depth to GW (feet)	Standard Deviation (feet)	Number of Measurements
41691	8.44	1.01	59
10894	5.53	1.19	21
11894	8.28	4.35	14
11994	5.91	1.44	12

3.8.3. Analysis of Groundwater Data

Figure 3-35, Figure 3-37, and Figure 3-38 show that Pu and Am concentrations in groundwater samples from all wells in the vicinity of GS03 have been low since the last quarter of 1994. High values of Am-241 and Pu-239,240 in samples from Well 41691 were measured in 1993 and early 1994. Technical specialists in the groundwater program determined that the probable cause of the elevated values might have been contamination of the borehole by surficial soils during installation. The upper 20 centimeters of soil are known to contain elevated levels of radionuclides[21]. Also, the technique of sampling with a bailer is known to disturb the sediments both in the bottom cap of the well and adjacent to the screened interval of the well.

Well 41691 was redeveloped during the second quarter of 1994 in an effort to remove surficial soils which may have been present in the borehole. Further, Wells 10894, 11894, and 11994 were installed using "aseptic" drilling methods, taking special precautions to prevent contamination by surface soils. Low TSS and radionuclide concentrations have been measured upgradient of Well 41691 (10894), downgradient of Well 41691(11894 and 11994), and in Well 41691 since redevelopment. This implies that elevated levels of Pu and Am measured in samples did not reach Well 41691 via groundwater transport, and are not indicative of a radionuclide contamination or migration situation near the Site boundary.

Despite the fact that elevated radionuclide concentrations have not been observed in the groundwater in the vicinity of GS03 since early 1994, the possibility of groundwater as the source of the high Pu and Am values recently observed in surface water must be considered due to the likely hydraulic connection between the shallow aquifer and the small pond above GS03. Further characterization of previously observed groundwater radionuclide contamination may facilitate comparison of typical groundwater radionuclide contamination to that observed recently in the surface water at GS03.

First, a fairly good linear correlation exists between TSS and both Pu-239,240 and Am-241 from samples taken from Well 41691. Therefore, the contamination previously observed in groundwater was uniformly associated with the sediments; though, as discussed previously, the TSS in these samples is likely to have originated from surficial soils. This relationship is presented in Figure 3-40.

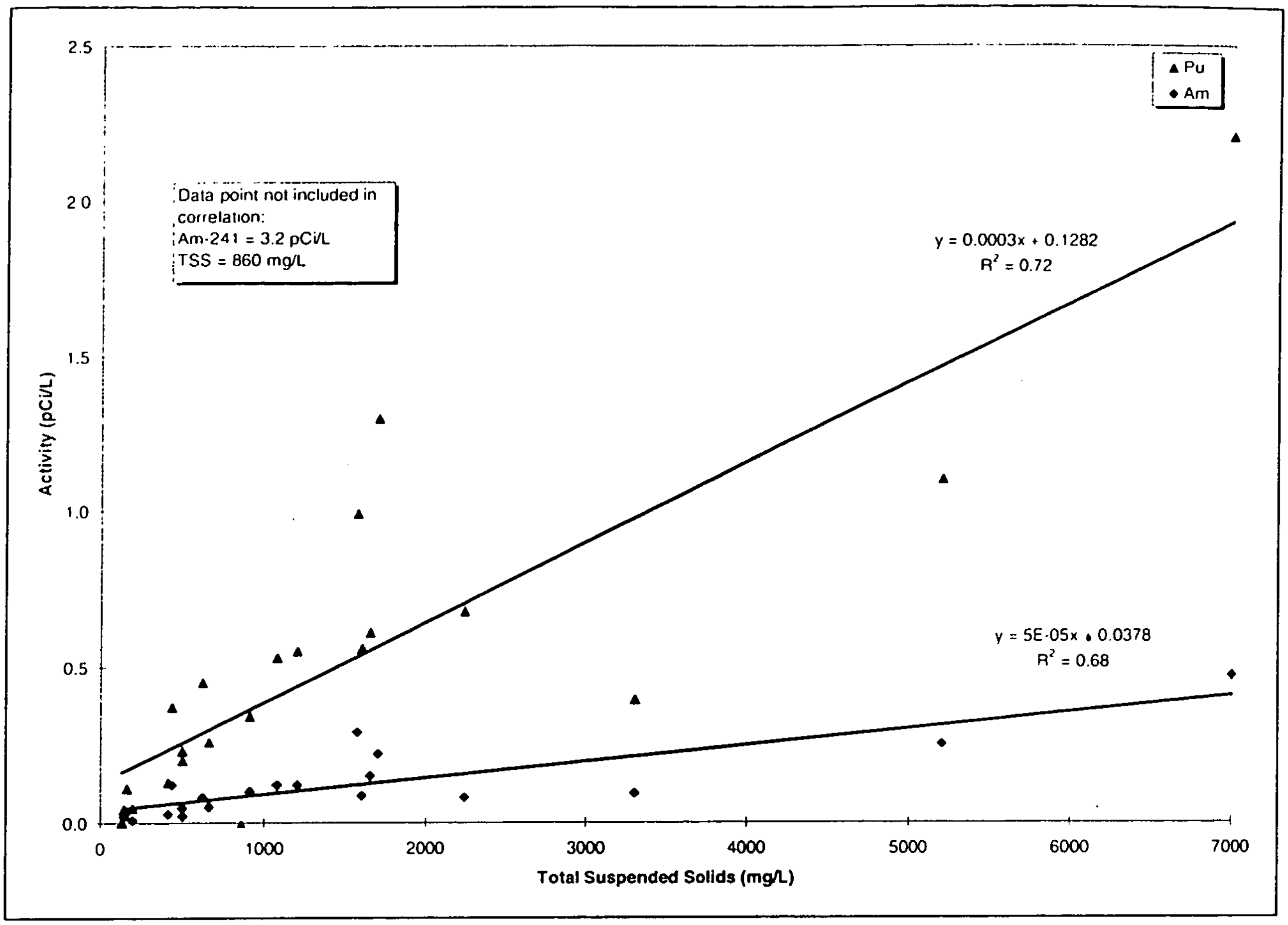


Figure 3-40. Relationship Between TSS and Radionuclide Concentrations in Groundwater Samples from Well 41691.

Significant correlations between radionuclide activity and TSS were not observed for data collected from the three surrounding wells installed in 1994 because all recorded activities were extremely low and within the range of reported laboratory accuracy.

Second, an apparent linear relationship exists between Pu and Am concentrations in samples from Well 41691. This relationship is presented in Figure 3-41.

Again, significant correlations were not observed for data collected from the 3 surrounding wells, presumably due to the low activities of all samples collected. Assuming no selective loss mechanisms occur to alter this ratio during transport of these groundwater contaminants to the surface, and assuming the ratio is constant with time, this relationship may be used as a sort of label. This relationship could then be used to eliminate or implicate groundwater as a possible source of surface-water contamination.

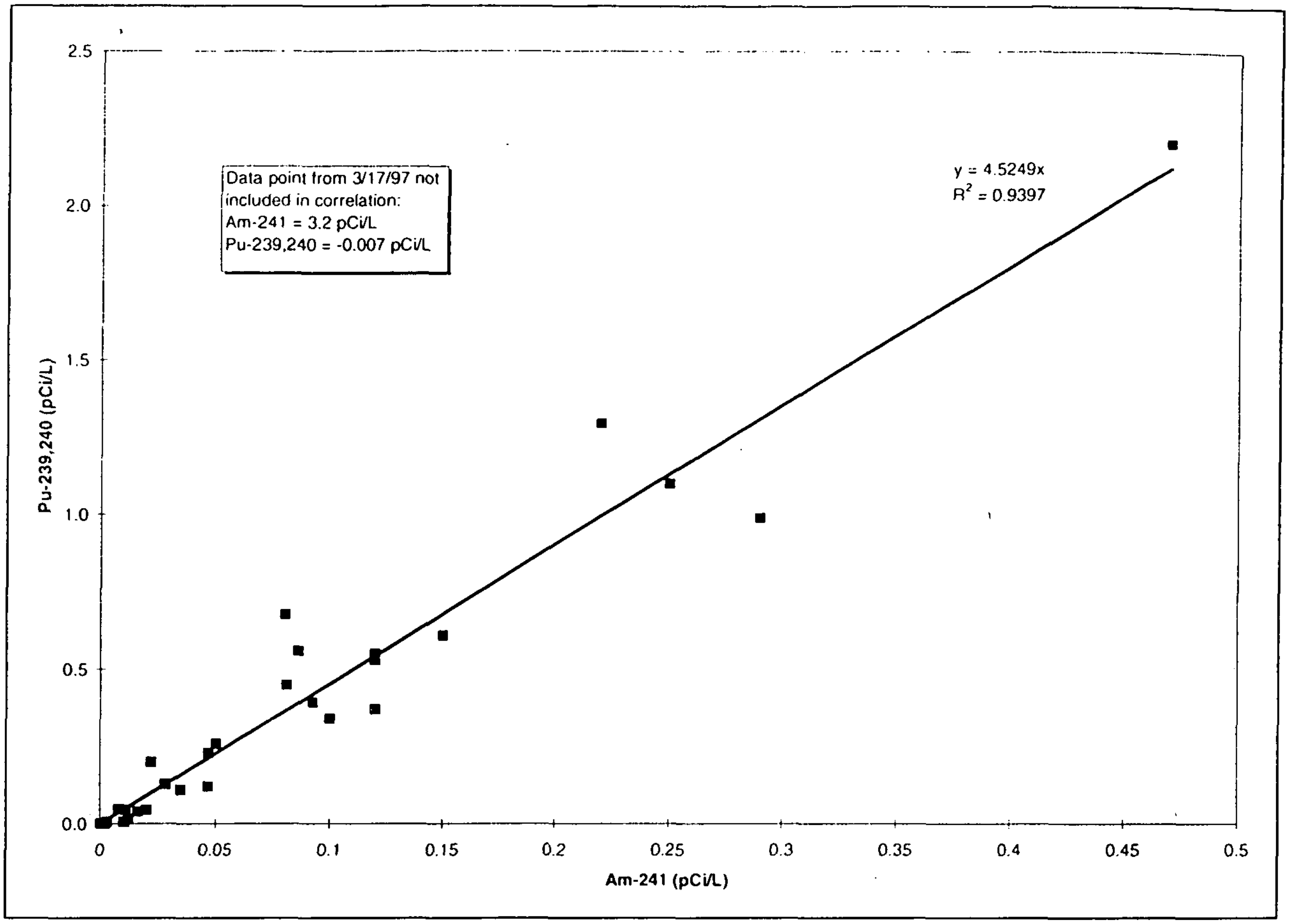


Figure 3-41. Relationship between Pu-239,240 and Am-241 in Groundwater Samples from Well 41691.

In short, no recent elevated values of Pu-239,240 or Am-241 have been observed in wells just upgradient or just downgradient of GS03. Further, previous elevated values observed in samples from Well 41691 are likely due to contamination of the borehole by surficial soils during installation. Therefore, it seems unlikely that the shallow groundwater is the source of recently observed surface water contamination. However, the probable hydraulic connection between the groundwater and the shallow pond above GS03 suggests the need for further analysis. The clear relationship between Pu and Am concentrations as well as between TSS and radionuclide activities may be useful in this investigation.

3.9. ACTINIDE MIGRATION STUDIES

The Site is currently involved in a comprehensive multi-year studies to improve understanding of the behavior and transport of Pu, Am, and uranium in the environment. This understanding of actinide migration should provide insight into the nature and movement of potential sources. The major goals of actinide migration studies are:

- Assess the long-term protectiveness of the actinide soil action levels on surface water;

- Design remedial actions that minimize actinide migration after Site closure and are protective of surface water quality; and

- Understand the actinide environmental transport mechanisms by refining the Conceptual Model (see Attachment 1 of the Path Forward for Actinide Migration, June 1997).

The FY97 scope of work for the Actinide Migration Studies group has focused on completing initial collection of soil and sediment samples for analysis (phase speciation of Pu and soil/water partitioning). Additionally, the investigators are evaluating models to estimate current and future soil erosion rates applicable to Site cleanup.

Preliminary results of this group have been reported and two major findings are applicable to this first phase of the Walnut Creek Source Evaluation effort and are discussed in the following section.

3.9.1. Summary of Actinide Migration Study Results To-Date

Preliminary results of the Actinide Migration Studies investigation have been reported in a stakeholder meeting on August 20, 1997 and elsewhere. To summarize the major finding potentially relevant to this source evaluation:

- Homogenized sediment cores extracted from Pond B-5 at various in-pond locations showed Pu activities between 0.09 and 0.57 pCi/g;

- Pond B-5 sediment show Pu loadings that vary slightly with depth between 0 and 15 cm. Preliminary results (for a sample collected mid-pond) varied from 0.27 pCi(Pu)/g at 9-10 cm to a maximum of 1.5 pCi(Pu)/g at a depth of 4-5 cm, whereas, the uppermost sediments showed a Pu loading of 0.58 pCi(Pu)/g; and

- Counting errors (one sigma) — a measure of practical detection limit — varied between 0.02 and 0.07 pCi/g.

Soils from the 903 Pad and Lip Area were also evaluated using selective chemical extraction techniques which test Pu's association with major, chemically distinguishable soil fractions — namely, exchangeable, carbonate, sesquioxide, organic, and residual fractions. The following findings are potentially relevant to this source evaluation:

- The methodology and protocols is limited to the sample background value of 0.048 pCi(Pu)/g;

- Loadings (pCi (Pu) per gram soil) in the various soil fractions show a nearly three order-of-magnitude range in activity loading within any particular sample;

- Organic and sesquioxide fractions show the greatest pCi(Pu)/g loadings with organic fractions showing loadings approaching 100 pCi(Pu)/g; and

- At the 903 Pad and Lip Area, Pu in soils occurs in the organic form.

3.9.2. Consultation with Actinide Migration Study Specialist

The Walnut Creek Source Evaluation team has consulted with the Actinide Migration Studies specialist, Dr. Bruce Honeyman (of the Colorado School of Mines). A summary of all information available through the August 1997 for the Walnut Creek basin exceedances was presented and discussed with Dr. Honeyman, and based on this and subsequent technical exchanges, two conclusions were evidenced:

- The technical approach of the onsite investigators is technically sound; and
- Additional technical and confirmatory support is available as needed through the Actinide Migration Studies.

Additional recommendations to improve the source investigation effort were also offered and are discussed in Table 3-8.

Table 3-8. Preliminary Recommendations of Actinide Migration Study Specialist

Recommendation	Actions Taken to Date / Status
Collect TSS samples with normal sampling.	TSS samples are planned for grab samples taken to support this investigation; the use of regular automated sampling to collect TSS samples is frustrated by the hold time limitation of 7 days.
Calculate/trend Pu-to-Am ratios for the elevated samples versus historical results.	Planned.
Examine relative analytical errors including counting, MDA, etc. (taking into account propagation of errors) to determine significance exceedance Evaluate minimum detectable activity and analytical uncertainty to determine their impact on compliance.	Detection limit issues and variability are being considered.
Determine Pu-240/Pu-239 isotopic ratios on exceedance planchets to assist in identifying source(s)	Good recommendation (also previously suggested by K-H Team). Planchets preserved for completion in FY98.
Examine slope or slump failures upgradient of GS03 as possible source(s).	Done. No indications.
With 4 individual samples returned with >0.15 pCi/L (Pu) consider the importance of "bunching" or fortuitous grouping (non-randomness) and its impact on compliance.	Statistical methods will be applied to the data.

Recommendation	Actions Taken to Date / Status
Attempt to correlate exceedances with other Site activities or natural events.	Previously recognized and being evaluated. ER is examining upgradient projects for impacts. A soils and sediments data map of local areas has been generated to identify possible contributing sources. Hydrograph, hyetograph, and WQ parameter overlays were developed and examined for visual queues and indications of possible correlations. Recent ER, D&D, and normal operational activities will also be reviewed and evaluated for WQ impacts.
Perform TSS, total organic carbon (TOC), and filtered/unfiltered radiochemistry as needed to address particle size of contaminant.	Good suggestion although there may be technical limitations placed by current automated sampling methods. These analyses are generally not amenable to the current automated sampling protocols and will require special grab sampling. Analyses will be utilized where hold times, sampling protocols (e.g., plastic carboys used in the automated sampling program cannot be used for TOC samples), etc.

4. PRELIMINARY DATA SUMMARY AND ANALYSIS FOR GS10

4.1. CONTINUATION OF RFCA MONITORING

Flow-paced sampling at GS10 and at upstream tributary locations SW022, GS27, and GS28 (upstream of GS10; Figure 4-2) has continued as specified by the SW IMP. Twenty-six samples have been collected at these locations in WY97. Future analytical results will be correlated with trends in the 30-day moving average values at GS10. This information may indicate water-quality patterns that could provide insight into the causes of the current values being measured at GS10.

4.2. WALK-DOWN OF DRAINAGE AREA

In response to the report of elevated levels of Pu and Am at GS10, a walk-down was performed of the drainage area tributary to GS10 (Figure 4-2). The purpose of the walk-down was to visually identify conditions which may have indicated source areas contributing to the elevated readings. Conditions which might indicate a potential source area are listed in Section 3.1.

The walk-down revealed no evidence of any man-made materials in the drainage pathways that indicate an uncontrolled release of contaminants. The drainage for GS10 is highly industrialized, and accordingly there is a multitude of possible sources of contamination. Many areas exhibited signs of high flows. Flows were large enough to breach stream banks. The erosion of the channel was typical of a "washout" that occurs during frequent periods of high flows due to the impervious areas in the drainage. Surrounding dirt roads and hillsides showed signs of runoff erosion, and many areas lacked vegetation to control erosion.

4.3. PRELIMINARY ASSESSMENT

The analytical results for the composite samples collected around the period have been verified. A review of historical monitoring data shows that these results are not unusual. Storm-event samples collected at GS10 from FY92 through FY96 (under pre-RFCA protocols) had an arithmetic average Pu-239,240 activity of 0.23 pCi/L with a maximum of 1.4 pCi/L (Figure 4-1). The apparent trend upward during WY97 is likely due to seasonally increasing flow rates which carry increased suspended material. To the best of our knowledge, during this time period no off-normal conditions were experienced at any D&D, SNM stabilization or ER cleanup activities that could have affected water quality.

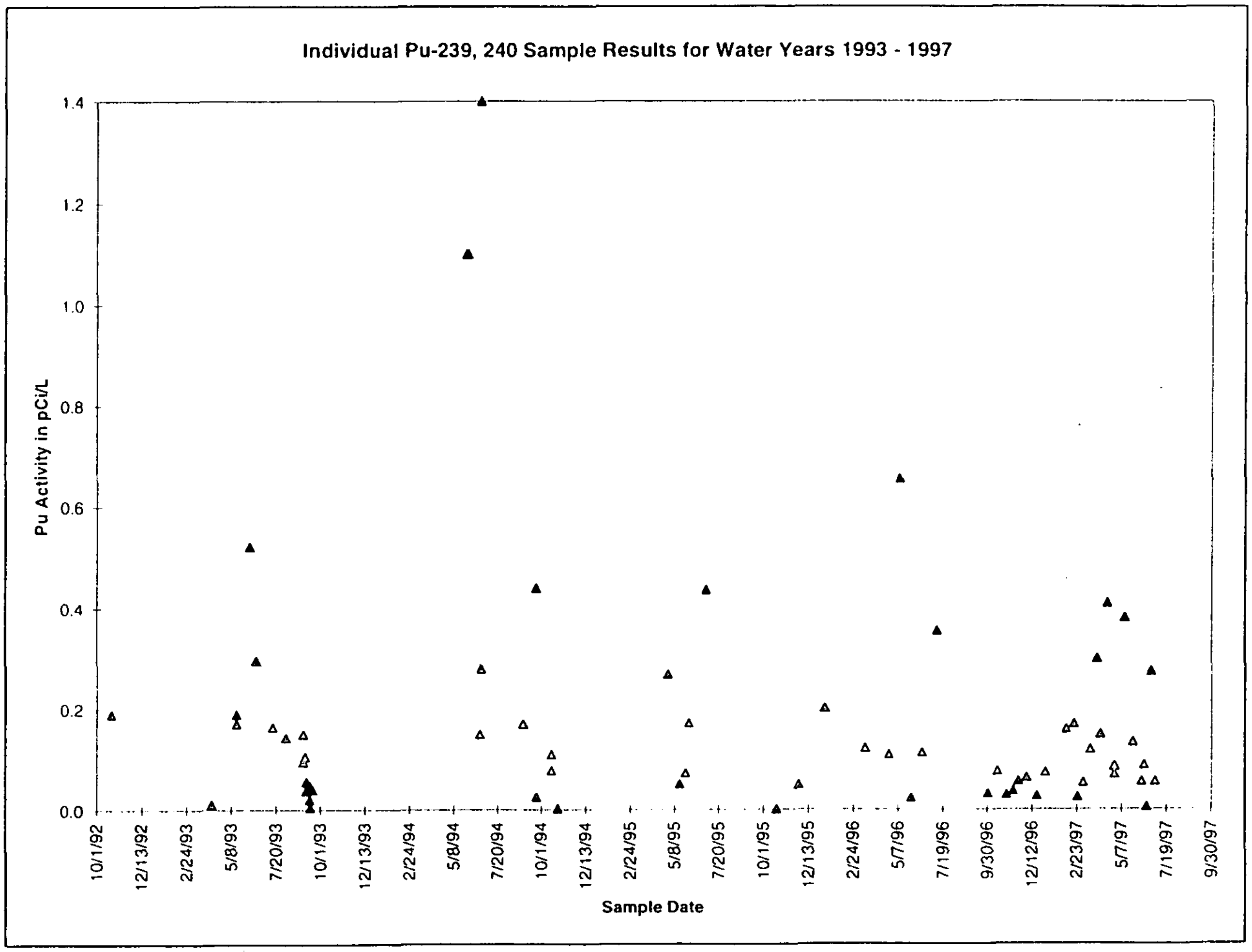


Figure 4-1. Individual Analytical Pu Results at GS10.

The drainage area for the surface-water monitoring location GS10 includes roughly 180 acres of the Site IA. Consequently, a variety of possible sources of radionuclide contamination could contribute to radionuclide activities at GS10. From the Site Historical Release Report[16], 32 Pu and general radionuclide-contaminated IHSSs were identified to be completely or partially within this drainage. The Pu IHSSs are listed and described in Table 4-1.

Table 4-1. Pu IHSSs Located in the GS10 Drainage.

IHSS #	Location/Bldg.	Dates	Description
108	900 Area, Trench T-1	November. 1954 - December 1962	Approximately 125 drums of depleted uranium chips and lathe coolant were buried in the trench. One drum reportedly contained an oily sludge with 4.3 pCi/g Pu.
109	900 Area, Trench T-2	July 1954 - August 1968	The trench received sewage sludge from the on-Site WWTP in addition to some crushed empty drums. The sludge was contaminated with uranium and Pu. This trench may have been primarily used for the disposal of non-radioactive liquid wastes.
112	900 Area, 903 Pad	1955 or 1958 - June 1968	1500 drums were stored on the 903 pad beginning in 1958. by 1960, significant leaking was noticed, and 50 drums had drained entirely. Heavy rains in 1967 resulted in the spread of Pu. Drum removal activities also resulted in the release of Pu.
113	900 Area, Mound Area	April 1954 - September 1958	In 1954, drums of contaminated combustible material from B444 were buried in a shallow trench and covered with soil. Several of the drums were reported to have contained pinhole leaks. Drum contents included depleted and enriched uranium and some limited Pu. All drums were removed by 1971.
141	900 Area	1952 - present	Several incidents have occurred when sludge from the WWTP overflowed the drying beds or was dispersed by wind.
150.4	700 Area, NW of B750	May 1969, 1980, and 1981	Tanks and pumps which handled decontamination fluid during the May 1969 fire were placed in the B750 courtyard. This area is suspected to have residual Pu contamination.
150.7	700 Area, S. of B776.	May 11, 1969	Following the May 1969 fire in B776/777, Pu tracked outside by fire fighting personnel was carried into the soil by rain. Airborne contamination was carried primarily to the southwest.
155	900 Area, 903 Lip Area	1964 - 1973	Contamination from the 903 Drum Storage Area was spread by wind and rain to adjacent soil.

IHSS #	Location/Bldg.	Dates	Description
157.1	400 Area, B442	1953 - unknown	B442 was used as a laundry facility to clean contaminated clothing from 1953 until approximately 1972. Soil samples taken in 1954 indicated the existence of contamination ten times greater than background in the ditches near B442. In 1962, barrels containing rags containing solvents and radioactive metal shavings was either spilled or leaked. The liquid drained east into the ditch north of B442.
165	900 Area, Triangle Area	1966 - 1975	In 1968, more than 6,000 drums were stored in an open field. High winds blew over as many as 150 drums at a time. The drums contained recoverable Pu-bearing wastes and residues. Scrap material also awaiting Pu recovery was also stored in the triangle area.
172	Central Avenue	June 11, 1968	A drum being transported from the 903 Drum Storage Area to B774 leaked, causing contamination to the roadways traveled. Radioactive materials spilled include Pu-contaminated oils and radioactive waste oil.
214	750 Pad		Multiple incidents of spilled or leaked pondcrete and saltcrete were reported in 1988, and 1989. Pondcrete consists of solidified low-level radioactive and hazardous waste extracted from the Solar Evaporation Ponds. Saltcrete consists of solidified low-level radioactive and hazardous waste extracted from process waste at B374 by distillation.

General radionuclide (rad) IHSSs include PAC #'s 122, 123.2, 148, 150.5, 153, 157.1, 157.2, 158, 159, 162, 164.1, 164.2, 164.3, 173, 176, 179, 180, 182, 194, and 213. These IHSSs resulted from a variety of incidents and activities including spills from process waste lines and waste boxes, exposed storage of contaminated equipment following fires, burning of contaminated oil, release from unfiltered fume hoods, and overflow from a valve vault. In addition to recorded IHSSs, the GS10 drainage contains multiple exposed-dirt parking surfaces and roads common in the IA.

Considering the size of the basin and the large number of possible sources, specific identification of the source responsible for elevated radionuclide concentrations observed in the surface water at GS10 is difficult given the available data. Low-levels of radionuclides, which may not require remediation under RFCA, could contribute loading to the Walnut Creek drainage. A more thorough investigation will be included in Progress Report #2. In fact, multiple sources are likely to contribute to radionuclide levels observed at GS10. Contributions from each source are also likely to be dependent not only on variables specific to the particular IHSS, but also on the nature of the storm event, including intensity, duration, and localization of rainfall.

5. GS03 SOURCE LOCATION ANALYSIS: HYPOTHESES AND CONCLUSIONS

In the following section, a discussion of source hypotheses is presented. To date, a singular source for GS03 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is entirely possible that multiple sources and transport mechanisms are responsible for the elevated activities at GS03.

5.1. WIDESPREAD OR LOCALIZED SOIL AND SEDIMENT CONTAMINATION IN GS03 DRAINAGE

Site sediments have a long history of contamination from historical releases. The section on historical releases had identified numerous events from the Site's production era which introduced radioisotopes to Site drainages both as airborne and in surface-water runoff. In Section 3.6, historic reports, the OU6 report, and a review of existing sediment data indicate relatively low level, widespread Pu contamination of soils and sediments throughout the Walnut Creek drainage. Airborne contamination would result in more distributed contamination, with levels diminishing further from sources such as the 903 Pad. The movement of contaminated stream sediments could result in localized contaminated deposits or more evenly distributed contamination, depending on how active natural erosion processes are in Walnut Creek. The evaluation of historic soil and sediment data reconfirmed the low level soil and sediment Pu contamination through out the Walnut Creek drainage. However, no anomalous Pu source areas (i.e., those well in excess of background) were evident in within the tributary areas to GS03.

Soil and sediment activities for samples in the drainage are generally below 2 pCi/g. Activities in nearby drainages has been measured at up to 7 pCi/g. If an average activity of 2 pCi/g is assumed, and with a TSS in surface water of 100 mg/l (Site monitoring locations typically show even higher TSS values; sometimes >1,000 mg/L), the expected activity would be 0.2 pCi/L. Given the soil activities in the drainage, the recent elevated activities at GS03 are possible.

The OU6 report acknowledged that past production mission activities from 1952 through 1973 resulted release of significant amounts of Pu contaminated surface waters to North and South Walnut Creeks, tributary to GS03. The B-Series pond reconstruction efforts from 1971 through 1973 were estimated to have re-mobilized several curies of Pu contaminated sediments, most of which would have been re-deposited in Pond B-1. Unknown amount would have continued downstream and been deposited along South Walnut Creek, and subsequently Walnut Creek. As the drainage evolves over time, contaminated sediments could be buried, and then re-exposed at some later date. These deposits may be re-mobilized during periods of high flows which can erode stream bed and banks. These mobile contaminated deposits could then move through the drainage, and eventually be 'flushed' from the system, as the localized deposit of contaminated sediments is exhausted. Therefore, legacy contamination in the form of stream sediments could affect water quality intermittently, as indicated by the intermittent activities seen in GS03 samples (discussed in Section 3.2). Even if a localized legacy deposit were to exist, the contamination would be expected to 'blur' as it moved through the drainage. In other words, an initial increase would likely be followed by a more gradual decrease. The samples collected during the period 6/25/97 7/6/97 (0.165, 0.184, 0.000 pCi/L) seem to contradict this assumption.

Although wide-spread low level contamination is acknowledged for soils within the Walnut Creek drainage basin, the pond discharge conditions under which elevated Pu values observed at GS03, and no precipitation occurred, are inconsistent with theory of overland flow as the source of contamination. However, it is possible that soils are eroded, moved by overland flow, and re-deposited in the stream bed with each passing storm runoff event. These deposited sediments could then be re-suspended by baseflow to provide significant Pu activity in diminished water volumes (i.e., not diluted by storm runoff).

However, as noted in Section 3.2.3, samples collected during A-4 discharges that showed significant runoff from precipitation which are indicative of overland flow (Figure 3-27), showed normal activities (0.022, 0.007 pCi/L). If runoff response from overland flow could be measured at GS03, then it is expected that any associated contaminated sediments woulb be available for sampling. Similarly, high runoff during the period 4/24/97 - 4/29/97 (up to ≈ 45 cfs at GS03), showed low levels of Pu.

5.2. LOCALIZED CONTAMINATION AT GS03 SAMPLING LOCATION

The Historical Release Report supports the hypothesis that localized contamination exists at GS03, specifically the flume pond and the surrounding soils/sediments. The area was identified as an IHSS due to past radioactive releases to the A-series and B-series drainages (as discussed in Section 3.7), and the soil in the area is potentially contaminated with radionuclides. The construction of the dam and flumes at GS03 involved movement of the soil. It is unknown if these materials were simply moved from the surrounding area (potentially contaminated), borrowed from some other area (potentially contaminated or uncontaminated), or brought in clean from offsite. A storm event on May 16-17,1995 caused the level of the flume pond to top the dam, and erosion took place on the dam face around the flumes. Potentially contaminated soil was exposed, and as further erosion took place over time, portions of the soil may be sloughing off in the water at the outlet. Since the sampler intake sits just below the flumes, it is possible that periodic erosion would result in the intermittent occurrence of elevated levels of Pu and Am in samples at GS03.

Sample results are pending that may or may not lend support to this hypothesis. Two sediment samples were taken from the areas of erosion on the flume pond dam, which will provide results of Pu and Am levels in these materials. In addition, a synoptic sampling event was performed along Walnut Creek between Pond A-4 and GS03, in order to determine spatial variability in water quality. Samples were collected both immediately upstream and downstream of the flumes. Results will be evaluated which may indicate localized loading at this particular location.

5.3. GROUNDWATER SOURCE

Due to the seasonally intermittent hydraulic connection between the groundwater and Walnut Creek, particularly at the flume pond above GS03, one hypothesis to explain the elevated levels of Pu and Am at

GS03 is that contaminated groundwater reached the surface by seepage. This hypothesis is supported by the fact that the sample with the highest total activity occurred during low flow rates which may have contained a significant proportion of groundwater seepage. Most of the available evidence, however, does not support this hypothesis.

As discussed in Sections 3.8, significantly elevated values of Pu or Am have not been observed in the wells just upgradient or just downgradient of GS03 for three years. Further, previous elevated values observed in samples from Well 41691 are likely due to contamination of the borehole by surficial soils during installation. Therefore, it seems unlikely that the shallow groundwater is the source of recently observed surface water activity.

Comparison of the activity and characteristics of previously observed radionuclide contamination in Well 41691, adjacent to GS03, with that observed in samples from GS03 further suggest that groundwater is not the source of surface water activity. To begin, of the three carboys collected between May 15, 1997 and July 1, 1997, only the first is likely to have contained water originating primarily from baseflow. The average flow rate during collection of this first carboy was 0.022 cfs. The other two composite samples were collected during a Pond A-4 discharge, resulting in average GS03 flow rates of 4.7 cfs and 2.1 cfs. Pu activities observed in the samples are inconsistent with this dilution. Specifically, if all the contamination observed in the first carboy (0.468 pCi/L) originated in the groundwater, then the following two carboys should have contained less than 0.005 pCi/L by dilution.

Focusing on the first carboy of concern collected May 15, 1997 and assuming groundwater was the only source of water flowing by GS03, the groundwater activities of Pu and Am would have to have been 0.465 pCi/L and 0.256 pCi/L, respectively. This is more than 5 times higher than the highest Am activity recorded in the wells surrounding GS03 since June, 1994, and more than two times higher than the highest Pu value observed over the same period. Further, if the groundwater was not the only source of flow at GS03 over this period, then the groundwater activity would have to have been even higher. As for the other two carboys of concern, assuming a constant discharge rate of groundwater to GS03 of 0.022 cfs, groundwater activities of Pu and Am for the second and third carboys of concern would have to have been greater than 18 pCi/L and 3.9 pCi/L, respectively, for groundwater to constitute the primary source. These values are more than 80 times greater than the highest values recorded over the past 3 years in Well 41691.

Next, the ratio of activities of Pu to Am in samples collected at surface water gaging station GS03 do not compare well to that estimated from Well 41691 data as discussed in Section 3.8.3. Focusing on the first carboy of concern collected May 15, 1997, the Pu to Am ratio in the surface water sample varies from that observed in Well 41691 by a factor of roughly 2.5. Assuming no selective loss mechanisms occur for Pu over Am during discharge of the groundwater to the surface water, this inconsistency would further suggest that groundwater is not the source of the contamination observed at GS03. Unfortunately, no TSS data is available from GS03 samples for comparison to the correlation observed from samples of Well 41691.

In short, for the past 3 years, radionuclide activities in groundwater wells near GS03 have consistently been well below values recently observed at GS03. Further, the distribution of activity among the three carboys of concern is inconsistent with the hypothesis of groundwater as the primary source. Finally, the characteristics of the recent surface water activity do not match those of the previously observed groundwater activities. Consequently, it is not likely that groundwater from the shallow aquifer below GS03 is the source of the recent elevated levels of Pu and Am. Any new data from groundwater Well 41691 will be presented in the following progress report if available.

5.4. MOBILIZATION OF SEDIMENTS IN POND AT GS03

The GS03 flume pond sediments as a potential source of elevated radionuclide levels at GS03 is supported by the fact that the source is available under all flow regimes. Even during periods of low flow, groundwater infiltration through the pond sediments provides a source of mobility for the sediments. During periods of high flow, disturbance of the sediments could occur as increased inflow takes place. However, when the assumption is made that Pu/Am activity is associated with the sediments, a correlation can be made between the concentration of TSS and the level of activity that challenges this theory. Using a range of TSS values from 1.3 - 130 mg/L (a magnitude of difference from an actual measured value of 13 mg/L), and an approximate measured value of Pu of 0.1 pCi/g for sediment samples taken in the GS03 flume pond, the calculated value of Pu in water would be 0.00013 - 0.013 pCi/L. A result in this range is much lower than the elevated levels measured at GS03.

Sample results are pending that may or may not lend support to this hypothesis. Three pond bottom sediment samples were taken in the flume pond, which will provide results of recent Pu and Am levels in the pond sediments. In addition, a synoptic sampling event (sampling the same "plug" of water at different locations) was performed along Walnut Creek between Pond A-4 and GS03, in order to determine spatial variability in water quality. Locations included the inlet to the flume pond, the outlet from the flume pond, and below the outlet at GS03. Results will be evaluated to determine if loading occurred from the flume pond sediments.

5.5. TRIBUTARY SURFACE-WATER SOURCE

Another hypothesis to address is that radionuclide contamination of surface water observed at GS03 originated from surface water tributaries to the Walnut Creek drainage. Two noteworthy tributaries, McKay Ditch and No Name Gulch, converge with Walnut Creek between the Terminal Ponds and GS03.

Several facts suggest that contaminated water sampled at GS03 did not originate as contaminated water in McKay Ditch and No Name Gulch. First, the high Pu activity recorded from the composite sample started on May 15, 1997 was collected during conditions of low flows. The flow rates observed at GS03 during collection of this sample (on the order of hundredths of a cfs) were likely much greater than any flow rates in the contributing tributaries. Further, No Name Gulch has a detention pond (possibly an old agricultural reservoir), which would detain runoff from No Name Gulch, which would dramatically increase the amount of precipitation required to produce flow reaching Walnut Creek. Second, 2 composite samples collected at GS03 showed elevated levels of Pu, despite the fact that there was no significant precipitation during the sampling period to produce runoff in the major tributaries. Finally, composite samples taken at GS03, encompassing the significant runoff event of April 25-29, 1997 yielded no elevated radionuclide activities. Flow rates reached ≈ 45 cfs at GS03 during the period 4/24/97 - 4/29/97, indicating that that tributaries contributed high flows correspondingly. If surface water from McKay Ditch and No Name Gulch were carrying activity to GS03, it would be expected that levels of activity would correlate with runoff.

Though there is significant evidence to suggest that the contaminated water observed at GS03 did not originate as contaminated water in the major tributaries, it remains possible that the tributaries contribute contamination in the form of solids to the Walnut Creek drainage. Results from the August 21, 1997 sediment sampling along Walnut Creek (see Figure 3-1) may reveal more information. Also, two new surface-water gaging stations were installed on these tributaries just upstream from the confluences with Walnut Creek. These locations are equipped to collect flow-paced samples and gage stream flow. The information collected at these monitoring stations should be useful in preparation of loading calculations and future source evaluation work.

5.6. AIRBOURNE CONTAMINATION

Another hypothesis to test to explain the elevated radionuclide levels is that contaminated materials were windblown from construction sites and other disturbed areas in the industrial area eastward to the Walnut Creek drainage. It is well known that predominantly westerly wind is a primary mover of contaminants offsite, and it is possible that airborne material was deposited upstream of GS03 on the water being sampled. Strong winds normally accompany storms in the RFETS area, and this combination of conditions conveniently links a source and transport mechanism with the detected high levels. While it is not possible to eliminated this hypothesis with the existing data, there are other observations that suggest that airborne transport is not the sole cause of these events.

Not all storm events with high winds have lead to observations of elevated radionuclide levels. Furthermore, there are often times when high winds occur without precipitation. Airborne transport of contaminants downwind into the drainage is more likely an ongoing event resulting in regular deposition of particles in the Walnut Creek drainage. The source of contamination, then, would be widespread deposition within the drainage, which is discussed in Section 5.1.

Since monitoring activities at RFETS include an extensive system of air monitors, a comparison of air monitoring results to events described in this report could identify potential correlations. Those data will be reviewed, as they become available, for possible inclusion in future reports.

5.7. 'HOT PARTICLES'

It is possible that the recent elevated measurements at GS03 are an indication of the existing variability of actinide in surface water. Previous sampling protocols may not have accurately characterized the true variability of surface-water activities. Current sampling protocols (see discussion in Section 6.2.4) have dramatically increased the number of grab samples collected at GS03.

The change in sampling protocol brings into question whether the recent 'elevated' measurements at GS03 and GS10 are actually deviations from the norm. In previous years, perhaps 50-100 grabs were pulled at these locations. Under the continuous flow-paced protocols, up to 2500 grabs may be pulled in a given year depending on location (over 1100 have been collected at GS03 to date). Assuming that activities in surface water are highly variable, due to either 'hot particles' or some other physiochemical mechanism, than an increased number of grabs would increase the probability of collecting water with relatively high activities. Consultation with the Actinide Migration Study Specialist and the DQO Statisticians is in progress regarding these sampling protocol effects. Results and analysis will be made available in subsequent reports.

5.8. POTENTIAL ISSUES WITH LABORATORY RESULTS

Another hypothesis concerns possible issues with the quality of analytical laboratory results received from GS03 as well as other RFCA locations. Variations in analytical data from what has been historically observed at GS03 could be attributed to many factors. These include changes in sample collection protocols (flow paced composites vs. grabs as previously described), use of many newly sub-contracted analytical labs (to date, 3 sub-contracted labs have been used vs. one onsite lab) and general analytical variability for radiochemistry samples at or near the level of detection. All sub-contracted labs are required to perform to the same Statement of Work (SOW) and should produce the same quality data. This is one of the more likely sources of sample result variability as each laboratory used may introduce it's own variability within the radiochemistry analysis process.

These issues will continue to be investigated and if additional information is encountered, updates will be provided in subsequent progress reports.

6. PROGRAM STATUS: ISSUES AND HIGHLIGHTS

6.1. REPORTING

Reporting of monitoring information is required by the SW IMP, RFCA, and Site administrative systems. This reporting requires notification of organizations such as Site contractors and departments, Kaiser-Hill, DOE, regulators, cities, and stakeholders. To facilitate the orderly dissemination of information, these reporting protocols are being streamlined and standardized. The details of these protocols will be discussed in Progress Report #2.

6.2. SAMPLING AND ANALYSIS

6.2.1. Verification of Elevated Analytical Results

All radio-chemical analyses collected for compliance with RFCA are analyzed by contracted laboratories under the direction of Kaiser-Hill, Analytical Projects Office (APO). Until December 1996, the onsite B881 Analytical Laboratory had routinely performed these analyses. DOE Headquarters determined that it would be more cost effective to close the onsite lab facilities and sub-contract all analytical work, including radiochemistry, to pre-qualified offsite labs. Beginning in early FY96, the APO developed detailed Statements of Work (SOW) for each functional area of analytical work needed by the Site. By early FY97, APO had audited and awarded contracts to a broad range of contract labs throughout the US. In December 1996, all surface water samples collected for compliance with RFCA were shipped to contract labs for analysis. Since late 1996, the APO has directed RFCA isotopic samples to 3 contract labs: Sanford Cohen & Associates in Alabama, Environmental Physics, Inc.in South Carolina and ThermoNuTech in California.

All analytical data are reviewed upon receipt by RMRS staff. If atypical measurements are found for parameters that are known to be historically higher or lower than the results reported, the APO is notified by RMRS. The APO subsequently contacts the laboratory with questions, concerns and/or requests for re-analysis and then provides any information back to RMRS. In the case of the initial elevated Pu sample from GS03 (0.22 pCi/l dated 4/11/97; Table 6-1), RMRS requested APO to confirm that all Quality Assurance / Quality Control requirements were met and to demand a re-analysis of the sample. However, insufficient sample volume remained for re-analysis but the lab confirmed that all SOW requirements for quality data were met. In the case of the three subsequent elevated Pu and Am analyses for GS03 (Table 6-1), similar contact was made with the APO. Confirmation of the data's quality was requested as well as re-analysis of the samples. Of the three re-analyses requested, only one quantitative confirmation of activity was received from the laboratory.

Table 6-1. Verification of GS03 Analytical Results.

Sample Date	Original Result	Action taken	Re-run result
4/11/97	0.22 pCi/l	Requested rerun, and verification that QA/QC were met by lab.	No sample volume remained - unable to rerun.
5/15/97	0.465 pCi/l	Requested rerun, and verification that QA/QC were met by lab.	Very low volume of sample remained for rerun - only able to qualitatively confirm elevated activity present.
6/25/97	0.206 pCi/l	Requested rerun, and verification that QA/QC were met by lab.	0.124 pCi/l
6/27/97	0.184 pCi/l	Requested rerun, and verification that QA/QC were met by lab.	Lab did not add tracer to sample causing analysis to fail - no rerun data available.

Once the samples are appropriately prepared for shipment, a chain of custody (COC) is prepared. One COC is prepared for each laboratory receiving samples for analysis. In many cases, multiple locations are listed on the same COC. As part of the investigation for GS03, all COCs for the samples in question were surveyed. The GS03 sample with a Pu activity of 0.465 pCi/l was shipped on the same COC as a GS10 sample; however, the sample volume for GS03 was 1 liter and the volume for GS10 was 4 liters, so it is unlikely the samples were switched. The GS03 sample with a Pu activity of 0.206 pCi/l was shipped with a GS11 sample, which had a typical Pu result of 0.002 pCi/L. It is not possible to determine if the samples were switched, however it is unlikely as no other GS11 samples had any elevated activities that might suggest the contamination source was from Pond A-4. Finally, the GS03 sample with a Pu activity of 0.184 pCi/l was shipped with samples from GS10 and GS11. Both samples from GS10 and GS11 showed typical activity levels (0.274 pCi/L and -0.009 pCi/L, respectively) that would tend to rule out samples being switched.

The SW IMP provides guidance for situations where an NSQ of water is collected in a carboy during a sampling interval. In the case of GS03 samples dated 4/11/97 and 5/15/97, there was less than sufficient volume for all analyses required. The Site choose to submit a minimal volume (1 liter vs routine 4 liters) of sample for analysis to provide a more consistent record of water quality during the first year of RFCA compliance. Routinely, 4 liters of sample is submitted to the analyzing lab, which splits the sample into two 2-liter aliquots, providing a sample for analysis and a backup aliquot in case the original analysis failes. Minimal sample volume can increase the minimum detectable activity (MDA) for a given analysis method. For the above mentioned samples there was an increase in MDA as compared to MDA for routine sample volume. A lower sample volume does not mean that the analysis is bad or of poor quality, unless the QA/QC criteria for the method are not met. It does mean that the analysis may be less sensitive and the margin for error in determining activity is less precise.

6.2.2. Cross-Contamination Risk Reduction

Numerous precautions are taken to reduce the risk of cross-contamination of samples for all surface water programs. After RFCA samples are retrieved from the field, the carboys are delivered to Advanced Science, Inc. (ASI) for sample preparation, containerization and sample delivery to the APO specified labs. Multiple carboys (on average 3-4) are dedicated to each site and are clearly labeled by location. Lids for each carboy are also plainly labeled and kept in individual bags to prevent contamination. After samples have been prepared and aliquoted, each carboy is thoroughly cleaned using Liqua-nox and a long handled brush (brushes are dedicated for RFCA POCs), and then rinsed with distilled water. The cleaned carboys are stored in new plastic bags until needed in the field.. ASI uses a stable cadre of staff that are experienced and knowledgeable in sample handling and processing to assure that there is consistency in sample preparation and handling.

6.2.3. Decrease in Sample Turn-Around Time at RFCA POCs

The majority of isotopic Pu, Am and uranium analyses are completed with a routine 30-35 day turnaround. An accelerated or rapid turnaround of 2 weeks for the same analytes increases costs approximately 25-50%. If all (approximately 33 for FY98) samples from GS03 were submitted to the analytical laboratory for rapid or 2 week turnaround, the estimated cost for FY98 would also be approximately 25-50% higher than for routine work. The Site's APO has contracted with labs with the understanding that they will be required to analyze surface-water samples requiring various turnaround times. As such, analytical quality should not be affected by requesting a 2-week turnaround for some samples and a 30-35 day turnaround for other samples. If some RFCA locations require shorter turnaround and samples collected during a given time frame (for example, every 2 weeks) could be batched prior to shipment, greater analytical efficiencies could be realized. If, however, individual samples are shipped as collected, and the laboratory does not batch samples together after receipt, the efficiency of the lab will be reduced and both turnaround time and quality could be impacted. The cost to accommodate 2-week turnaround for all current RFCA POCs in FY98 is projected to be 25-50% higher than the current cost.

In response to the recent elevated measurements at GS03, all samples from GS03 are currently being analyzed with an accelerated two-week turnaround time. Accelerated analysis for all RFCA POCs is currently being evaluated.

The current labs under subcontract with the APO are meeting the SOW required detection levels of 0.03 pCi/L for Pu and Am using between 1.5-2.0 liters of water. Increasing the volume of water used for analysis would reduce the detection levels, or MDA, but would extend the analysis time as a larger quantity of water would require concentration (boiling down in a very controlled manner) prior to analysis. This could impede meeting an accelerated 2-week turnaround. Another way to increase or enhance MDA is to increase sample counting time, however, it would also extend the overall analysis time and could prevent the labs meeting the accelerated 2-week requested turnaround.

6.2.4. FY97 Change to Continuous Flow-Paced Sampling at RFCA POCs and POEs

As determined by the DQO process and specified in the SW IMP, CFP samples are currently collected at all POEs and POCs. The DQO process determined that this form of sampling protocol is required to provide adequate information for the Site to make complex decisions regarding surface-water management. This form of sampling uses automated samplers to collect multiple flow-paced grab samples in composite containers. Composite samples are collected up 4 times a month, providing good resolution or water-quality variation. Since the samplers are running continuously, water quality is measured continuously. This allows for accurate calculations of variations in water-quality, fate and transport of constituents, and mass loading analysis (see Section 3.2).

Previous site monitoring at these locations involved grab, time-composited grabs, and flow-paced rising limb storm-event sampling. This type of sampling took 'snapshots' of water quality, but lacked the continuity for assessing overall water quality. Load estimations needed to be calculated using arithmetic averages of these sample results, which made more accurate assessment of the variability of actinide transport difficult.

This change in sampling protocol brings into question whether the recent 'elevated' measurements at GS03 and GS10 are actually deviations from the norm. In previous years, perhaps 50-100 grabs were pulled at these locations. Under the CFP protocols, up to 2,500 grabs may be pulled in a given year depending on location (over 1,100 have been collected at GS03 to date). Assuming that activities in surface water are highly variable, due to either 'hot particles' or some other physiochemical mechanism, than an increased number of grabs would increase the probability of collecting water with relatively high activities. Consultation with the Actinide Migration Study Specialist and the DQO Statisticians is in progress regarding these sampling protocol effects. Results and analysis will be made available in subsequent reports.

6.3. AUTOMATED SURFACE-WATER MONITORING

6.3.1. Continuous Flow-Paced Sampling

As part of the source evaluation, and in accordance with RFCA, continuous flow-paced sampling has continued as specified in the SW IMP. Samples collected from GS03 and GS11 since August 7, 1997 and samples collected at GS10 since July 8, 1997 are presented in Table 6-2. Analytical results for these samples have not been returned from the labs. No samples have been collected at GS08 since May 12, 1997.

Table 6-2. Log of Recent Walnut Creek Samples.

Location	Sample Start Date	Sample Collection Date
GS03	8/8/97	8/29/97
	8/29/97	9/1/97
	9/1/97	9/4/97
	9/4/97	9/8/97
GS10	7/8/97	7/16/97
	7/16/97	7/23/97
	7/23/97	7/31/97
	7/31/97	8/4/97
	8/4/97	8/6/97
	8/6/97	9/1/97
	9/1/97	9/18/97
GS11	8/29/97	9/1/97
	9/1/97	9/4/97
	9/4/97	9/8/97

Upon receipt of laboratory results, 30-day moving average calculations will be updated for inclusion in Source Evaluation Progress Report #2.

One significant programmatic modification has been implemented to gather more information which may be beneficial to the source evaluation. Since August, 1997, laboratories have been instructed to run TSS analysis on any samples which have not, by virtue of the sample collection duration, exceeded the hold time of 7 days. Collection of TSS information will aid in the determination of transport mechanisms for Pu, which forms strong associations with solids.

6.3.2. Synoptic Sampling Event for GS03 Drainage

Analytical results from 7 temporary monitoring locations (shown in Figure 3-1) will be evaluated in Progress Report #2. These locations were used to synoptically sample the first 24 hours of an A-4 discharge (8/29/97-8/30/97) at various locations along Walnut Creek between Pond A-4 and GS03. Automatic samplers were used to collect 75 time-paced grabs in a 15-liter carboy. The samplers were spaced along Walnut Creek to determine spatial variability in water quality. Each sampler was started as the discharge reached them, effectively sampling the same 'plug' of water. Each composite sample was analyzed for total radionuclides, total metals, dissolved metals, TSS/TDS (total dissolved solids), hardness, and sand silt split.

Additionally, field grab samples for TOC/DOC (total organic carbon / dissolved organic carbon) were collected at the start time of each composite sample. Surface-water radionuclide activities from these samples will be analyzed for spatial variability using loading analysis which may indicate the location of a source area. Correlations between radionuclide activities and other water-quality results will be evaluated and may indicate transport mechanisms and location of source areas. Summary statistics for these new values will be evaluated against results from GS03 and GS11.

Additional synoptic sampling may be conducted to support ongoing source evaluations. These samples will be targeted to further define any localized source areas.

6.3.3. Winter Freeze Protection

POC gaging stations in Walnut Creek and Woman Creek have been evaluated for winter freeze protection including outfitting with submersible heat tape/coils or other modifications to reduce the possibility of sample intake line freezing and the attendant gaps in sample collection. This will allow sampling equipment to more reliably collect water samples during extreme cold weather.

Heat tape systems that have been chosen require either 110v or 220v AC line power to provide adequate temperature regulation. The vendors that have been consulted have not recommended an attempt to construct DC freeze-protection systems. AC line power currently exists at some sampling locations, but has proven to be undependable, often failing during inclement weather. Therefore, AC supplies will need to be upgraded at most locations, while other locations will require complete construction of power lines to the gaging station.

Gaging stations will be inspected for needed repairs or construction, and upgraded as needed. Attached is a preliminary findings and proposal for improvements to power requirements at the Walnut Creek and Woman Creek monitoring locations.

Table 6-3. Electrical Configurations and Required Improvements for RFCA Sample Sites.

Location	Site Configuration	Improvement	Other Improvements
POC GS01; Woman Creek at Indiana Street	Powered by 12v battery system, solar charged with regulator.	Run AC line power from Indiana Street to sampler housing shed. Install 3 prong outlet at sampler housing shed.	Upgrade flume to meet flow requirements. This can be accomplished by incorporating specifications outlined in previous engineering design projects for GS01. Install UPS battery backup for AC power.

Location	Site Configuration	Improvement	Other Improvements
POC GS03	Powered by extension cord from AC line power in fiberglass building.	Run AC line power from existing fiberglass shed to sampler housing. Test existing AC service for reliability. Upgrade existing AC service to meet expected instrumentation load demands.	Install UPS battery backup for AC power. Install shed, with AC outlet box at flume.
POC GS08	Powered by extension cord at outlet box adjacent to Drexelbrook Flow Meter.	Test existing AC service for reliability. Upgrade existing AC service to meet expected instrumentation load demands.	Install UPS battery backup for AC power.
POC GS11	Powered by 12v battery system, solar charged with regulator.	Test existing AC service for cause of repeated power failure, and repair as needed. Upgrade existing AC service to meet expected instrumentation load demands. Install AC power outlet box in sheet metal shed located at flume.	Install UPS battery backup for AC power.
POC GS31; Pond C-2 outlet	Powered by 12v battery system, solar charged with regulator.	Install 3 prong outlet at sampler housing shed. Test existing AC service for reliability. Upgrade existing AC service to meet expected instrumentation load demands.	Install UPS battery backup for AC power.
POE GS10	Powered by 12v battery system, solar charged with regulator.	Run new AC service from nearest available line source. Install outlet box at sampler shed for instrumentation.	Install UPS battery backup for AC power.
POE SW027; SID at Pond C-2	Powered by 12v battery system, solar charged with regulator.	Run new AC service from nearest available line source. Install shed, with AC outlet box at flume.	Install UPS battery backup for AC power.
POE SW093	Powered by 12v battery system, solar charged with regulator.	Run new AC service from nearest available line source. Install shed, with AC outlet box at flume.	Install UPS battery backup for AC power.

6.3.4. Increase in Baseflow Sample Frequency at GS03

The SW IMP has determined through the DQO process that collection of one composite sample at gaging station GS03 in the intervening period between Terminal Pond discharges is adequate to characterize baseflow leaving the Site. To accomplish this, samplers are paced based on historical records of baseflow and runoff to collect 2.5 times the minimum required for volume for laboratory analyses, giving an acceptable range of error in flow prediction of 60%. In the event that historical records overestimate the baseflow between discharges by more than 60%, and an insufficient volume of water is collected to complete the required analyses, the IMP specifies that the collected sample may be recorded as NSQ and discarded. To date during WY97, three NSQ samples have been discarded. As a result, a small fraction of the total surface water leaving the Site via GS03 is uncharacterized, confounding loading and 30-day average calculations as well as source evaluation investigations.

To further minimize the number of NSQ samples, WM&T Group has elected to collect two composite samples during the intervening period between Terminal Pond discharges. To accomplish this, samplers are paced based on historical records of baseflow and runoff to collect two samples with 2.5 times the minimum required volume for laboratory analyses, effectively increasing the acceptable range of error in flow prediction from 60% to 80%. This procedural change was implemented on 9/9/97, and was successful in preventing an NSQ sample for the period between 9/9/97 - 9/24/97.

6.3.5. Installation of Source Location Monitoring Locations

Tributary to GS03

Two new gaging stations, GS33 and GS35, have been installed upstream from GS03 in an effort to better characterize contributions to Walnut Creek from the major tributary subdrainages. These locations are installed to support the Source Location Decision, as specified in the SW IMP. Collection of flow record and continuous flow-paced samples for laboratory analysis at these locations will facilitate loading calculations to determine which tributaries may br sources of contamination.

GS33 is located on No Name Gulch just above the confluence of No Name Gulch and Walnut Creek. Construction and instrumentation of GS33 was completed on 9/15/97, and the location was immediately operational. The flow measurement device at GS33 is a 9.5-inch Parshall flume, capable of measuring flow rates up to 4.4 cfs. GS35 is located on McKay Ditch just above the confluence of McKay Ditch and Walnut Creek. Construction and instrumentation of GS35 was completed on 9/18/97, and the location was immediately operational. The flow measurement device at GS35 is a 3-foot contracted rectangular weir, capable of measuring flow rates up to 18.4 cfs.

Both locations are equipped with electronic flow meters to collect 5- and 15-minute flow record and automated samplers programmed to collect continuous flow-paced composite samples. Power at each location is solar with battery backup. Operational protocols currently applied to maintain all RFCA surface water monitoring locations will also be applied to GS33 and GS35.

A third Source Location monitoring location will be installed during the first quarter of FY98. The gaging station will be located on Walnut Creek, just upstream of the confluence of McKay Ditch. This location will consist of a flume equipped with the same flow measurement and sampling capabilities as GS33 and GS35.

Tributary to GS10

Additional upstream monitoring locations will be installed to continuously sample surface-water flows to further delineate the GS10 tributaries. Monitoring locations will be determined based on the analysis of existing data to further scrutinize the GS10 drainage basin. These locations will employ flow control devices (e.g. flumes, weirs) and continuous flow-paced and/or synoptic storm-event sampling to calculate mass transport to determine which sub-drainages may be contributing contaminants. Water-quality information from sub-drainages may also indicate the degree to which source areas are localized or wide-spread. Initially, perhaps two to three locations might be considered as a first step to investigate the GS10 drainage basin. Additional monitoring locations may be installed to support the ongoing source evaluations. These locations will be targeted to further determine any localized source areas.

6.4. SOIL AND SEDIMENT SAMPLING

6.4.1. New Locations Tributary to GS03

Sediment samples were collected on 8/21/97 at 19 locations along Walnut Creek (shown on Figure 3-1). These analytical results will evaluated in Progress Report #2. Sediments from the flume pond and the drainage pathway tributary to GS03 will be analyzed for spatial variability that may indicate the location of a source area. Summary statistics for these new values will be evaluated against historical results to indicate changes. Additionally, these values will be compared to surface-water radionuclide activities in a mass loading context.

Additional soil and sediment sampling is anticipated to support ongoing source evaluations. These samples will be targeted to further define any localized source areas.

6.4.2. New Locations Tributary to GS10

Soil and sediment samples will be collected from the drainage tributary to GS10. Locations of these samples will be determined based on the analysis of existing data. These locations will be sited to indicate spatial sediment/soil activity variations and to fill any gaps in existing data. Sediment/soil activities from the drainage pathways tributary to GS10 will be analyzed for spatial variability which may indicate the location of a source area. Summary statistics for these new values will be evaluated against historical results in the area to indicate changes. Additionally, these values will be compared to surface-water radionuclide activities in a loading context.

Additional soil and sediment sampling is anticipated in support of the ongoing source evaluations. These samples will be targeted to further define any localized source areas.

6.5. GROUNDWATER SAMPLING

Additional groundwater samples may be collected from existing or new wells with need based on the ongoing source evaluations. These samples will be targeted to further determine any localized source areas.

6.6. SUMMARY

The Site is in close communication with regulators, cities, and stakeholders regarding the status of source evaluations and monitoring programs. Table 6-4 is a recent Weekly Project Status Report (9/22/97) issued by the Site.

The Source Evaluation Progress Report #2 to be submitted on November 15, 1997 will include the assessment of current existing monitoring data for GS10, and any new data from GS03. A preliminary assessment for SW093 will also be included. The following will be included in Progress Report #2 for Walnut Creek:

- Preliminary conclusions and hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- An assessment of existing monitoring data for GS10;
- A detailed description of new sediment/soil sampling locations for GS10;
- An assessment and incorporation of available new data for GS03;
- A preliminary assessment for SW093;
- A summary and of current Actinide Migration Study findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

Table 6-4. Weekly Project Status Report: September 22, 1997.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
1	Verify laboratory results and 30-day average calculations for the recent (May-June 1997) GS03 water quality measurements.	8/14/97	8/15/97	Completed	Verified laboratory results; re-checked 30-day average calculations. Lab results pass QA/QC; details will be published in Plan Report #1 on 9/30/97.
2	Perform "walk-down" of stream channel and adjacent areas between Pond A-4 and GS03 looking for any unusual conditions which might indicate new sources.	8/15/97	8/15/97	**Completed**	Observed no unusual conditions in Walnut Creek that would indicate a localized source area; several minor stream bank cuts and stream bottom fill locations were noted. Details will be published in *Plan* Report #1 on 9/30/97.
3	Confirm that water quality measurements at GS03 have returned to normal levels.	8/14/97	NA	Waiting on results	Five (5) carboys have been collected at GS03 and have been submitted for analysis. Carboy for period beginning 8/5/97 had Pu/Am of 0.002 pCi/l. Still waiting on results for carboys which initiated sampling on 8/8, 8/29, 9/1, and 9/4. The current GS03 carboy has been collecting baseflow samples since 9/9.
4	Re-analyze remaining sample aliquots for two of three elevated composite samples from GS03.	8/14/97	8/21/97	**Completed**	One result confirmed original measurement; other sample failed re-analysis.
5	Perform appropriate notifications to Site personnel and Stakeholders regarding elevated (May-June 1997) measurements at GS03.	8/15/97	8/15/97	**Completed**	Site and Stakeholders were notified. Call downs included both Occurrence Reporting and RFCA reporting contacts. Occurrence report filed 8/15/97. Regulators notified through RFFO on 8/15/97.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
10a	Compile all existing water, soil, and sediment radio-analytical results for GS03 and associated upgradient locations.	8/21/97	9/15/97	**Completed**	Analytical results were derived from RFEDS and submitted to GIS for posting to review data in map view. Draft map of sediment and soils prepared and under review. Summary and analysis to be published in Plan Report # 1 on 9/30/97.
10b	Verify all existing water, soil, and sediment radio-analytical results for GS03 and associated upgradient locations.	9/15/97	9/30/97	Ongoing	Initial draft map will be used to refine the mapping process and produce a final map for the source evaluation study. Summary and analysis to be published in Plan Report # 1 on 9/30/97.
11	Perform loading and fate and transport analyses. Evaluate statistical correlations using water-quality, flow, and precipitation.	8/21/97	9/30/97	Hydrologic, precipitation, and WQ results are being evaluated for trends and correlations.	Evaluation is ongoing to aid in the definition of near-term activities; results and hypotheses will be made available as they are developed. Careful consideration will be given to the difference in results and hypotheses; interim results and evaluation will be published in *Plan* Report #1 on 9/30/97
12	Perform synoptic sampling event in Walnut Creek for the first 24-hours of the upcoming Pond A-4 discharge.	8/25/97	8/30/97	**Completed**	This event monitoring utilized seven (7) automated samplers to collect time-paced composite samples for the first day of Pond A-4 discharge (8/29 - 8/30/97), effectively sampling the same (initial) 'plug' of water as it moves through the Walnut Creek drainage. The samplers performed flawlessly with each composite sample receiving the targeted 75 grabs. Grab samples for TOC and DOC were also taken on the rising limb of the discharge as an indicator parameter to define potential correlations. Accelerated WQ results will be used to evaluate for water-quality trends (results may be returned as soon as 9/19/97). Results and associated evaluation should be available for inclusion in *Plan* Report #2 on 11/17/97.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
6	Perform sediment sampling in Walnut Creek upgradient drainages tributary to GS03	8/21/97	8/21/97	**Completed**	Prepared Sampling & Analysis Plan. Collected 3 pond bottom samples from pond at Walnut and Indiana; collected 16 samples from streambeds upgradient; preliminary results expected by 9/8/97; results and evaluation will be published in *Plan* Report #1to be published on 9/30/97
7	Perform additional sediment and soil sampling upgradient of GS03.	Approx. 9/15/97	Approx. 9/30/97	Pending validated results of initial sediment sampling	Addendum to Sampling and Analysis Plan being prepared. Additional samples will be collected to clarify or complement results of earlier sampling. Sampling and Analysis Plan to be released as a controlled document. Completed, validated data is expected 9/23/97.
8a	Accelerate appropriate analyses to ensure timely data availability.	8/21/97	9/5/97	**Completed**	Accelerate sample turnaround to maximize data availability for decision making.
8b	Perform value engineering analysis to support acceleration of compliance monitoring.	9/6/97	9/30/97	**Completed**	Evaluate laboratory costs, turn-around times, and data quality. Collect and compare costs of accelerated analytical turnaround. Per K-H, all GS03 samples through end of FY97 will be expedited for two (2) week turn-around. Expected that turn-around will continue into FY98 for GS03.
9a	Perform laboratory services check.	8/21/97	9/15/97	**Completed**	QC samples are routinely collected according to RFCA technical design document (every 20th sample). This continues as designed. K-H has requested all POC's data be validated. Cost is not yet determined on expected turn-around.
9b	Submit additional sample duplicates, splits, rinseates, and blinds	9/15/97	11/15/97	Ongoing	The need for additional QC sampling is under evaluation.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
13a	Install additional monitoring stations upstream of GS03.	8/25/97	9/15/97	**Completed 2 of 3** GS34 will be installed the week of 9/29/97	New gaging station locations selected and readiness approvals being received for installation. Locations will collect continuous flow-paced samples to assess transport in No Name Gulch, McKay Ditch, and Walnut Creek. Ecological approvals completed 8/27/97; soil disturbance approvals completed. Gaging station GS33, on No Name Gulch at Walnut Creek, was installed 9/10/97. Gaging station GS35, on McKay Ditch at Walnut Creek, was installed 9/12/97. Startup and operation will take place on 9/15/97 for both locations. Gaging station GS34, on Walnut Creek upstream of McKay Ditch, will be installed the week of 9/29/97. Results and evaluation will be published as they are received.
13b	Install additional monitoring stations upstream of GS03 if needed to provide increased resolution.	9/30/97	12/31/97	Ongoing	Information derived from the new gaging stations will be used to determine whether additional locations are needed.
14a	Examine impact of RFCA watershed improvements on downstream WQ.	9/30/97	12/31/97	Ongoing	Watershed improvements were performed in FY96 and FY97. WQ results are being compiled and analyzed to provide information on contaminant transport. Information will be published in *Plan* Report #3 on 12/31/97.
14b	Review historical release report(s) for possible correlation with RFCA monitoring results.	9/8/97	9/30/97	Ongoing	Historical releases for the Walnut Creek drainage will be reviewed to determine whether past releases may have contributed to the elevated Pu and Am measurements. Results will be published in *Plan* Report #1 on 9/30/97.
15	Evaluate all Site activities potentially impacting GS03 water quality.	8/21/97	9/30/97	Ongoing	Results and evaluation will be published in *Plan* Report #1 on 9/30/97.

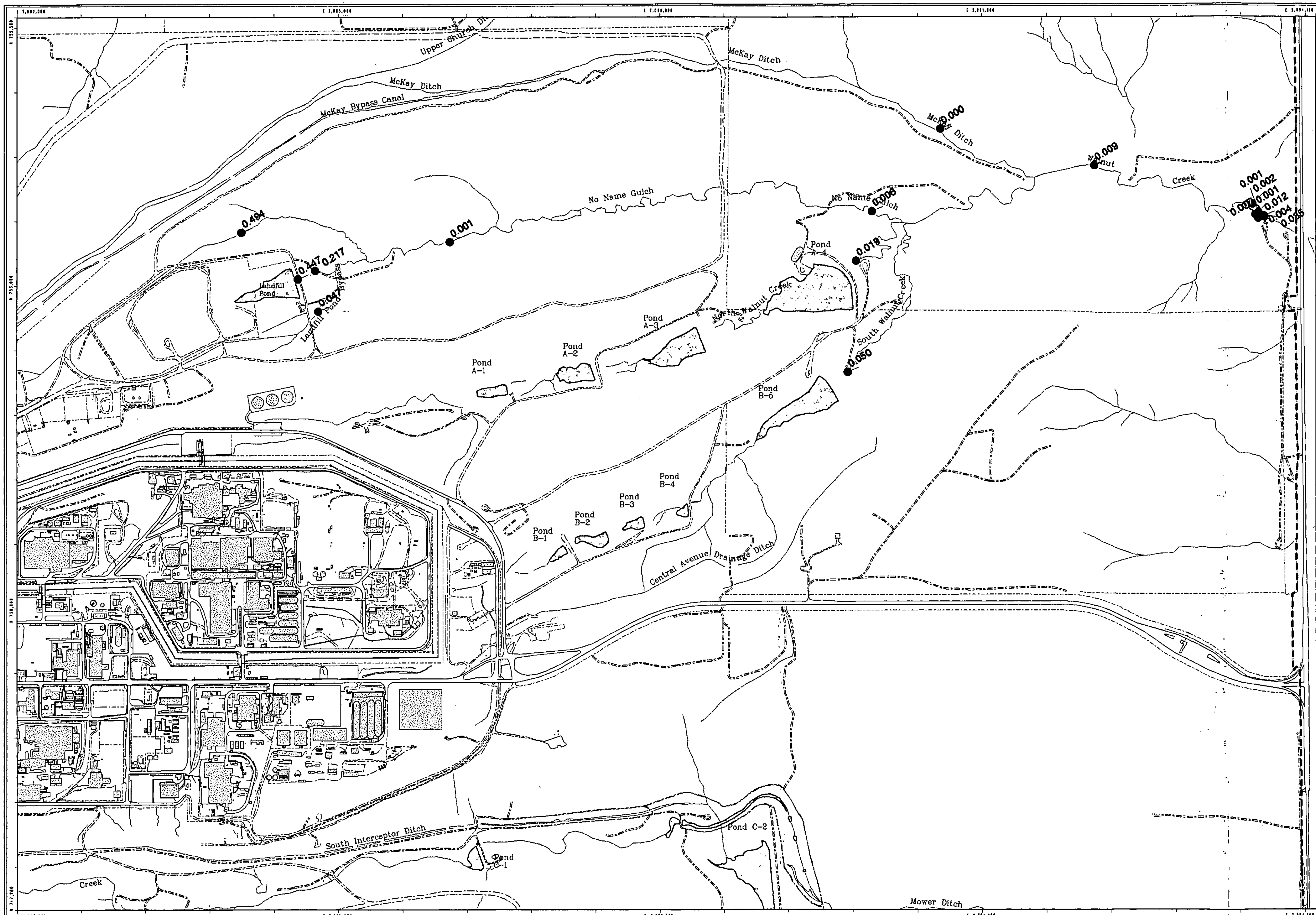
	Project Activity	Sched. Start	Sched. Finish	Status	Comment
16	Perform additional walk-downs to assess No Name Gulch and McKay Bypass ditch sub-drainages and to identify origin of baseflow.	8/20/97	8/20/97	**Completed**	Drainages show indication of recent high flow rates (likely from large storm events in first weeks of Aug. 97). Baseflow was confirmed exiting pond at GS03 with no inflow noted. No indication of current baseflow from seeps or springs; no unusual conditions which may visually indicate a localized source area. Details will be published in Plan Report #1 on 9/30/97.
17a	Identify data gaps and uncertainties in monitoring approach and protocols to improve monitoring program.	8/18/97	9/30/97	Ongoing	Initial evaluation of pacing and baseflow sample collection frequency and developed change to sampling protocols that minimizes chances of low-volume samples.
17b	Continue to identify data gaps and uncertainties in monitoring approach and protocols to improve monitoring program.	9/30/97	12/31/97	Ongoing	Detailed evaluation of pacing and baseflow sample collection frequency and developed change to sampling protocols that minimizes chances of low-volume samples.
18	Share recent developments and information with the K-H Team's Actinide Migration investigators and solicit additional source evaluation hypotheses.	8/29/97	9/15/97	Ongoing	RMRS completed data exchange and consultation with Dr. Bruce Honeyman (CSM) on August 29th. Meeting minutes are being compiled and recommendations incorporated into the Plan for Source Evaluation and Preliminary Actions for Walnut Water-Quality Results. Extra sediment was set aside (from that collected on 8/21/97) to allow for independent evaluation by Actinide Migration investigators.
19	Evaluate ground water data for wells in the vicinity of GS03.	8/21/97	9/30/97	**Completed**	Preliminary trending of Site-boundary well near GS03 (Well # 41691) shows GW Pu levels diminishing from approx. 1.5 pCi/L to < 0.05 pCi/L between 1992 and 1997. Three additional wells were installed using improved drilling methods and these wells have subsequently showed no elevated Pu or Am. Results and associated evaluation will be included in Plan Report #1 on 9/30/97.

	Project Activity	Sched. Start	Sched. Finish	Status	Comment
20	Complete and provide draft of RFCA-required *Plan for Source Evaluation and Preliminary Mitigating Actions for Walnut Creek Water-Quality Results* ("*Plan*").	6/17/97	7/17/97	**Completed**	Delivered draft *Plan* to regulators 7/17/97; comments on *Plan* from regulators received 8/5/97 and 8/7/97. Response to comments sent to DOE 8/27/97 for transmittal to regulators. May-June 1997 water-quality results from GS03 will be addressed in latest revision of *Plan*. *Plan* will be amended to perform source evaluations for Walnut Creek basin above GS03 and GS10.
21	Complete *Final Plan for Source Evaluation and Preliminary Mitigating Actions for Walnut Creek Water-Quality Results*	8/5/97	9/15/97	**Completed**	Provide draft for internal K-H Team on 9/10/97; transmittal to DOE 9/12/97; and transmittal to regulators on 9/15/97.
22	Complete Report #1 for the *Plan*	8/21/97	9/30/97	Ongoing	Report #1 will include analysis and evaluation of historic reports and readily available information and environmental data for GS03. A preliminary assessment for GS10 will also be included. Initial conclusions regarding source will be formulated and incorporated in this report. Analysis of data received after 9/15/97 will not be included in this report.
23	Complete Report #2 for the *Plan.*	10/1/97	11/15/97	Pending	Report #2 will include analysis and evaluation of existing data for GS10 and the newly acquired GS03 information and environmental data; with need determined by the Phase 1 activities. A preliminary assessment for SW093 will also be included. Conclusions regarding GS10 and GS03 sources will be refined after inclusion of the new data and incorporated in this report.
24	Complete Report #3 for the *Plan.*	9/30/97	12/31/97	Pending	Report #3 will include analysis and evaluation of all SW093 investigative information and environmental data. Newly acquired GS03 and GS10 information and environmental data will be included; with need determined by the previous evaluation activities. Conclusions will be finalized and incorporated in this report.

	Project Activity	**Sched. Start**	**Sched. Finish**	**Status**	**Comment**
25	Complete Final Evaluation Report and Mitigating Action Plan addressing elevated Walnut Creek sources.	1/1/98	4/15/98	Pending	The Final Evaluation Report will include the results and conclusions of the source evaluation actions. The Mitigating Action Plan will evaluate options (cost, efficacy, etc.) and identify alternatives for effectively removing and/or reducing impacts of identified sources.

Figure 3-30

Surface Water Sampling Locations Tributary to GS03



Legend

Sampling Stations

- Selected Sediment Monitoring Location (Pu values in pCi/g)

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 11610
1 inch represents approximately 968 feet

250 0 500 1000 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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MAP ID: 97-0169-GS03 September 29, 1997

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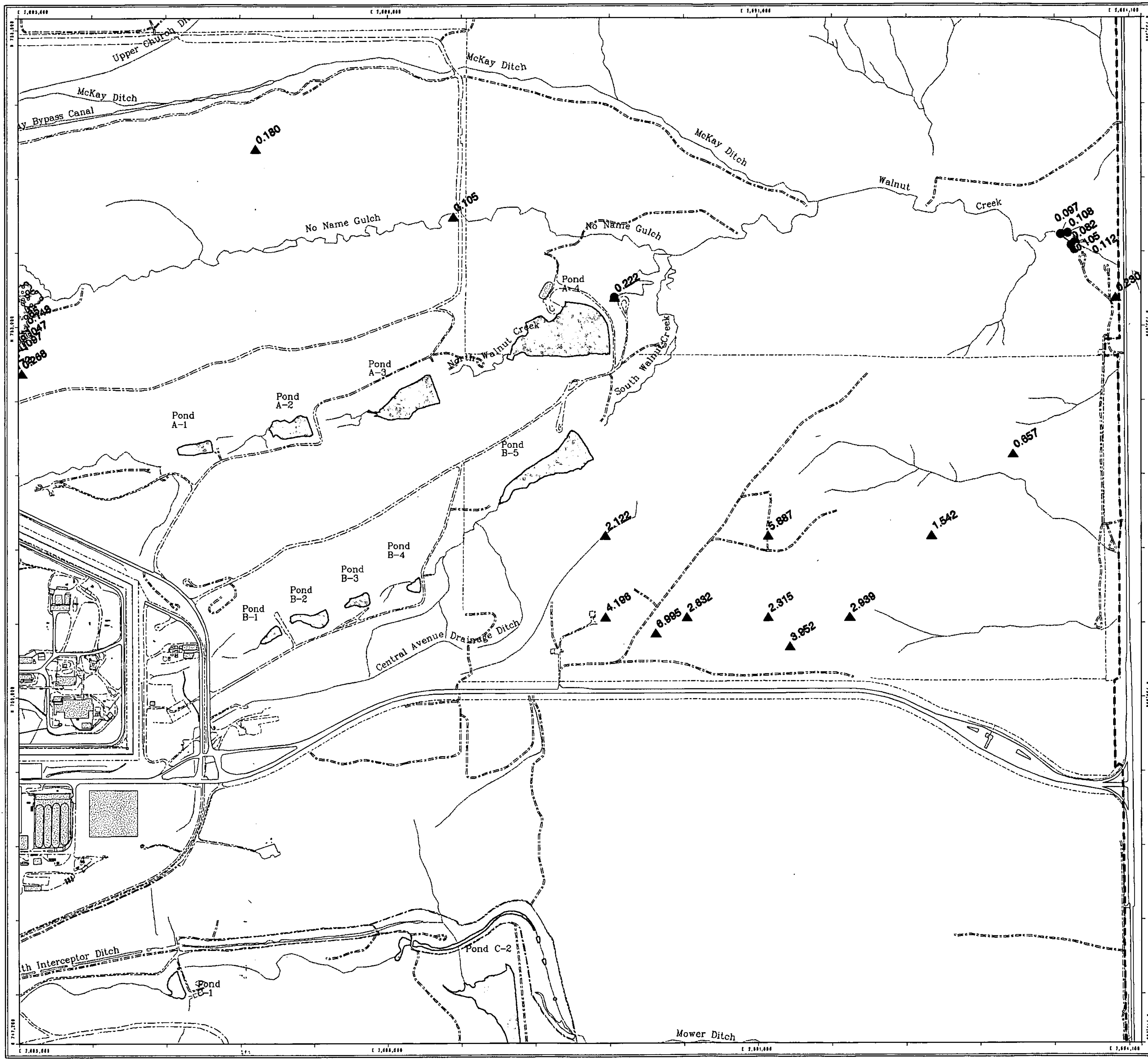

Figure 3-32

Surface Soil & Sediment Sampling Locations Tributary to GS03

Legend

Sampling Stations

- ● Selected Sediment Monitoring Location (Pu values in pCi/g)
- ▲ Selected Surface Soil Monitoring Location (Pu values in pCi/g)

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the othophotographs. 1/95

N

Scale = 1 : 10710
1 inch represents approximately 893 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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MAP ID: 97-0188-GS03 September 29, 1997

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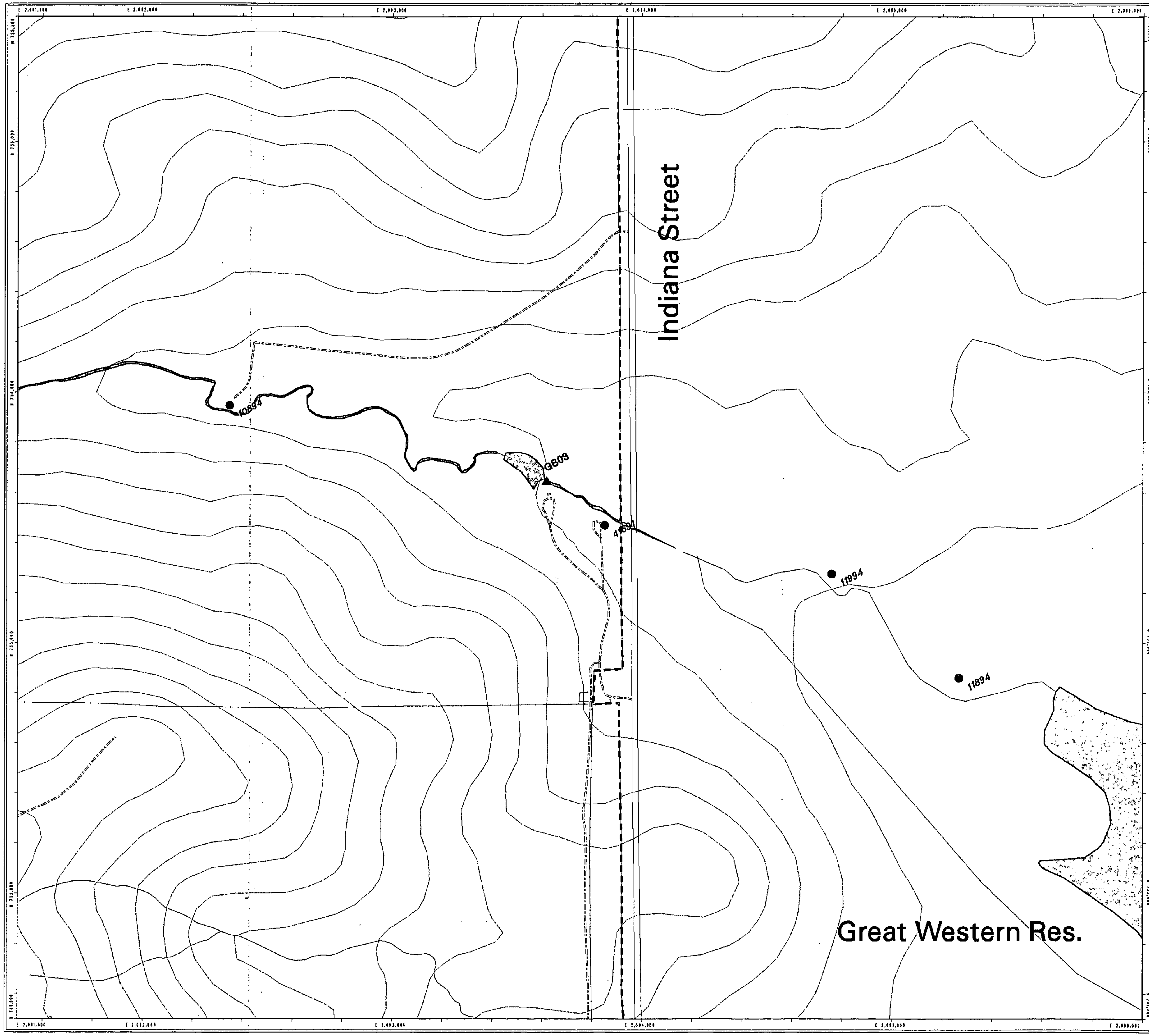

Figure 3-34

Groundwater Monitoring Wells Adjacent to GS03

Legend

Gaging & GW Sampling

- ▲ Gaging Station (Point of Compliance)
- ● Selected GW Monitoring Well

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contours
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 5160
1 inch represents 430 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0188-GS03 September 29, 1997

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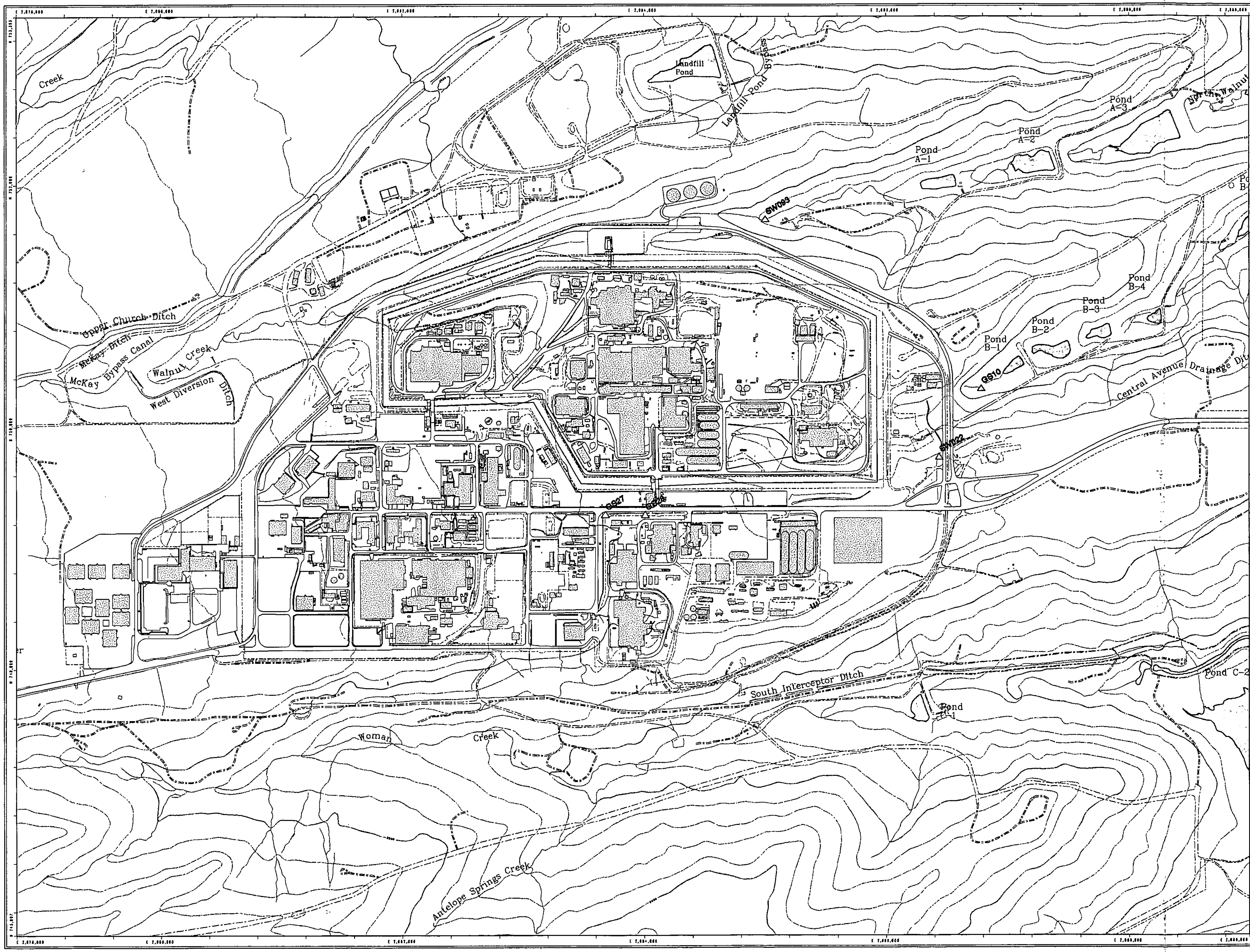

Figure 4-2

GS10 Drainage Area
(with Selected SW Monitoring Locations)

August 1997

Legend

Gaging & Sampling Stations

△ Surface Water Monitoring Location

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the othophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was capture by the Remote Sensing Lab, Los Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution.
The DEM post-processing perfromed by MK, Winter 1997.

Scale = 1 : 9790
1 inch represents approximately 816 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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MAP ID: 97-0189-GS03 September 29, 1997

/gis2/projects/fy97/97-0189/gs03-em pl-fig3-2.aml